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FISCAL YEAR 1992 AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S RENEWABLE ENERGY AND ENERGY CONSERVATION PROGRAMS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED SECOND CONGRESS

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FISCAL YEAR 1992 AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S RENEWABLE ENERGY PROGRAM

TUESDAY, APRIL 9, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON ENVIRONMENT,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2318, Rayburn House Office Building, Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. SCHEUER. The hearing this morning of the Subcommittee on Environment on the authorization of the Department of Energy's renewable energy program will come to order.

We have with us Congresswoman Connie Morella of Maryland, a very active and productive member of this subcommittee. I suspect other members will be coming in.

This is the first time this subcommittee has had a hearing on our new energy jurisdiction. We have just received an expanded jurisdiction in alternative fuels, in competitiveness, and in energy efficiency. We are very happy to receive this jurisdiction and we do want to make clear that we have had no responsibility for any of the misdeeds or non-deeds of the past. We start out with a "tabular rossa," a clean slate, so to speak, and we look forward with great pleasure to scrutinizing the entire field of energy alternatives.

Today, we will consider the Department of Energy's budget request for the renewable energy program of DOE within the context of the priorities established in the so-called National Energy Strategy.

Before I go any further, let me introduce the ranking minority of this subcommittee, Congressman Don Ritter of Pennsylvania. We are delighted you are here, Don.

Since 1979, and it is important to note, DOE's budget for renewable energy programs has been cut over 90 percent. An over 90 percent cut in the last decade in real dollars for renewable energy. I think we have to look at this so-called National Energy Strategy through a prism that says 90 percent cut in real dollars over the last 11 or 12 years for authorization for energy alternatives. This came about through a variety of causes. Low petroleum prices in the 1980s caused Federal investment in alternative energy supply research and development to dwindle, and tax credits for renewable energy investment were caused to be reduced and to a great part eliminated. Much of the private sector investment in these technologies was dissipated. As a result, renewable energy technologies have been severely impeded in their efforts to extend their range of development and application.

The President's so-called National Energy Strategy calls for a continuing increase in research and development to reduce costs and improve the performance and efficiency of emerging technologies. Specially, his Strategy would call for increased funding for R&D related to renewable energy to reduce the costs of and increase industry confidence in solar, wind, biomass, and geothermal technologies to generate electricity. Then the National Energy Strategy would call for increased funding for R&D on systems to convert municipal solid waste to energy; for increased funding for R&D on new biomass feedstocks and conversion technologies to develop economical liquid fuels; and increased funding for R&D on innovative building materials and designs to use renewable energy for direct heating, cooling, and lighting in buildings.

While the National Energy Strategy, so-called, clearly tries to identify the areas which need increased funding, there seems to be a bit of schizophrenia about it because while on the one hand and the written word, the President and the Administration call for increased funding, but on the other hand, when it came to dollars that have been requested, the original message was lost in the shuffle, as the Office of Management and Budget cut it down to size and as the translation from the DOE recommendations, through the Office of Management and Budget recommendations, came through. As a matter of fact, the Office of Management and Budget cut Jim Watkins' request for renewable energy programs by 26 percent. The budget proposal sent over to the Congress contains a request for $164.1 million for fiscal year 1992, a mere 4 percent over the 1991 level. That's really an inflation adjuster, no more, no less. This increase of 4 percent is insufficient to meet the energy challenges of the future, which include lessening our dependence on imported fuels, mostly fossil fuel energy, and environmentally destructive sources of energy.

Congress is not blameless in this matter either. The committee's most recently enacted legislation for renewable energy, the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989, in fact contains an authorization level that is below the President's request. So we have been part of the problem. Congress has not distinguished itself by being part of the solution. I might say though that now that this subcommittee is responsible for the authorization of this program for alternative fuels, I think we can expect to see some readjustment in funding priorities. It is clear that Congress must work constructively and cooperatively with the Administration to develop a rational national energy plan in which an increasing proportion of our energy is supplied by renewable sources.

If we adhere to the President's vision for renewable energy technology, we will reduce our dependence on imported oil, if we can match the dollars to the program, and we will have a cleaner and more healthful environment and increase the competitive profile of U.S. industry. And I might also say in passing, that virtually all of the other advanced developed countries of the world are concentrating on increasing their energy supplies through non-fossil fuel sources. They are racking their brains to find environmentally acceptable ways of adding to energy supply and fuel efficient and energy efficient ways of adding to our energy supply or perhaps reducing energy demand by rational means of conservation, rational means of energy efficiency.

I visited Con-Ed yesterday in New York and they have a raft of proposals to reduce consumer demand for electricity. They have all kinds of subsidies and incentives for consumers to buy the most recent very energy efficient light bulbs, for example. They have all kinds of incentive programs for apartment house owners as well as individual homeowners and apartment dwellers to acquire more fuel efficient lighting, more fuel efficient air conditioning and heating, more fuel efficient refrigerators. And they provide direct subsidy as well as assistance in financing for all of these things. So a segment of our industry is involved usefully. There is a tremendous market around the world for energy efficient systems of all kinds—for transportation, for cars, for trucks, for buses—fueled by alternative fuels, fueled by gas, fueled by electricity. The electric car is something that has an enormous market out there if we can develop it in a fuel efficient way. And to the credit of our automobile, to the very real credit of industry, Ford, General Motors, and Chrysler are engaged in a joint research and development program to produce an efficient and productive battery; that has been the stumbling block for decades to the widespread use of the electric car. So, astonishingly enough, the auto industry is apparently playing a very constructive and useful role here, and I congratulate them for that.

Abroad, other nations are spending far greater shares of their energy R&D budgets—in fact, in some cases, more dollars per capita than the United States is—on renewable energy technologies. The U.S. manufacturers of renewable energy systems have been losing ground to foreign competitors in a pattern that is all too reminiscent of the decline of the domestic consumer electronics industry in the 1970s. There is an enormous market out there to be filled. Congress and the Administration, working cooperatively together, can be the engine that liberates the talents and the energies and the initiatives, the resourcefulness of the private sector toward meeting all kinds of needs for alternative energy sources other than fossil fuels.

I look forward very much to working with Assistant Secretary Michael Davis to chart a long-term course for increasing the profile of renewable energy sources in our Nation. The subcommittee is pleased to welcome Michael Davis and the other panelists here to share their vision for the future of renewable energy technologies.

Before I recognize Secretary Davis, I am going to recognize the ranking Republican member of this committee, Congressman Don Ritter of Pennsylvania for his statement.

Mr. Ritter. Thanks a lot, Mr. Chairman. I regret to say that I am in two hearings at the same time. It is an occupational hazard around here. The other is H.R. 5, the strike-breakers bill, which is in our Energy and Commerce Subcommittee.

Mr. Chairman, I want to commend you for addressing an issue which is vital to our Nation's future. Although the danger of interruption in the flow of oil from the Middle East has decreased, we are still vulnerable to future disruptions and price shocks. We must act swiftly and decisively to redefine our Nation's energy policy.

Particularly, we must consider reductions and replacements of gasoline as transportation fuel if we wish to reduce dependence on imported oil. That is where the dependence is by far the greatest.

You mentioned Con-Ed's project on reducing demand and increasing the use of some technologies that are energy saving. To the extent that Con-Ed needs to do this in a big way, they need to do it because they are burning a lot of oil, most of which is imported from the Persian Gulf. It is insane to burn oil to make electricity. Frankly, New York City has available to it a $5.5 billion nuclear energy generating capacity in Shoreham which is fully licensed, which is deemed to be safe, which would replace vast amounts of foreign oil. And, it is not being used. Now, this is an immediate way to substitute for this very dangerous dependence that we face. Also, it does not give off carbon dioxide or other ambient air quality standard emission products which we are spending vast amounts of money to reduce through the Clean Air Act.

The Chairman mentioned the Ford, GM, Chrysler battery project. I think it is a great project. We need more efficient batteries. But let's face it. When we come home at night after using our cars in the daytime, we are going to plug that car into some source of electricity, hopefully, reasonably priced electricity. The whole battery electric car debate is going to be dependent not only on battery technology, but reasonably priced electricity that is available.

The President's National Energy Strategy states that renewable energy can play a larger role in meeting our energy needs. In fact, the use of renewables has increased since 1970; in 1990, renewable energy resources supplied about 8 percent of our energy needs. And there has been technical progress since the 1980s, when technologies to exploit renewable resources were more costly and more prone to failures.

Adding renewables to the range of energy choices can contribute to a stronger economy. Using renewable energy has the potential to spur innovation by American firms, and, if applied in the appropriate facets of our energy using economy, displace imported oil. But, there is not a one-to-one correspondence between alternative energy and displacement of foreign oil, which is the major problem that the United States of America faces. There are also benefits to the environment that need to be considered.

Still, there are considerable obstacles to overcome before renewables will increase their share of the energy marketplace. Despite technical advances, few renewable energy technologies are proven on a large-scale and cost-competitive with existing major energy sources. For most technologies, system reliability, efficiency, availability, and ease of maintenance are still problematic.

The Department of Energy says it proposes to spend nearly $204 million this year for research and development in renewable energy technologies and related programs in energy storage and electric energy systems. That's higher than what the Chairman has mentioned, and it will be interesting to see where the differences are. These programs can stimulate growth in the use of renewables. Continued R&D, in conjunction with industrial partners, will help reduce costs and improve the performance of these new technologies.

As you point out, Mr. Chairman, funding for renewable energy slipped sharply in the past decade. In these tough budget times, as I understand, the President has requested more funding for DOE R&D in renewables than this Committee itself authorized in the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989. That is somewhat of a signal that the Administration is committed to move forward with R&D in renewable energy.

Mr. Chairman, thank you very much for your indulgence. I yield back the balance of my time. Unfortunately, I will have to go to my other hearing where I am also Ranking Member.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Ritter follows:]

THE HONORABLE DON RITTER (R-PA)
OPENING STATEMENT
HEARING ON RENEWABLE ENERGY R&D
APRIL 9, 1991

MR. CHAIRMAN, I COMMEND YOU FOR ADDRESSING AN ISSUE WHICH IS VITAL TO OUR NATION'S FUTURE. ALTHOUGH THE DANGER OF INTERRUPTION IN THE FLOW OF OIL FROM THE MIDDLE EAST HAS DECREASED, WE ARE STILL VULNERABLE TO FUTURE DISRUPTIONS AND PRICE SHOCKS. WE MUST ACT SWIFTLY AND DECISIVELY TO REDEFINE OUR ENERGY POLICY.

AS WE DISCUSS OUR ENERGY FUTURE, WE NEED TO CONSIDER A WIDE RANGE OF POLICY ALTERNATIVES TO BREAK IMPORTED OIL'S GRIP ON US. OUR ENERGY POLICY MUST ADDRESS OUR NATIONAL SECURITY, ENVIRONMENTAL CONCERNS, GLOBAL COMPETITIVENESS, AND INCREASING DEMAND FOR ELECTRICITY. NO SINGLE OPTION HOLDS THE KEY TO SUCCESS. INSTEAD, WE MUST PURSUE A DIVERSE, BALANCED APPROACH, FOCUSING ON ALL AVAILABLE TECHNOLOGIES.

PARTICULARLY, WE MUST CONSIDER THE REDUCTION AND REPLACEMENT OF GASOLINE AS A TRANSPORTATION FUEL.

THIS IS WHERE OUR DEPENDENCE ON IMPORTED OIL IS GREATEST.

THE PRESIDENT'S NATIONAL ENERGY STRATEGY STATES THAT RENEWABLE ENERGY CAN PLAY A LARGER ROLE IN MEETING OUR ENERGY NEEDS. IN FACT, THE USE OF RENEWABLES HAS INCREASED SINCE 1970; IN 1990, RENEWABLE ENERGY RESOURCES SUPPLIED ABOUT 8 PERCENT OF OUR ENERGY NEEDS. THERE HAS BEEN TECHNICAL PROGRESS SINCE THE 1980S, WHEN TECHNOLOGIES TO EXPLOIT RENEWABLE RESOURCES WERE COSTLY AND PRONE TO FAILURES.

ADDING RENEWABLES TO THE RANGE OF ENERGY CHOICES CAN CONTRIBUTE TO A STRONGER ECONOMY. USING RENEWABLE ENERGY HAS THE POTENTIAL TO SPUR INNOVATION BY AMERICAN FIRMS, AND DISPLACE IMPORTED OIL, THEREBY IMPROVING OUR TRADE POSITION. THERE ARE ALSO BENEFITS TO THE ENVIRONMENT TO CONSIDER.

STILL, THERE ARE CONSIDERABLE OBSTACLES TO OVERCOME BEFORE RENEWABLES WILL INCREASE THEIR SHARE OF THE

ENERGY MARKETPLACE. DESPITE TECHNICAL ADVANCES, FEW RENEWABLE ENERGY TECHNOLOGIES ARE PROVEN ON A LARGE SCALE AND COST-COMPETITIVE WITH EXISTING MAJOR ENERGY SOURCES. FOR MOST TECHNOLOGIES, SYSTEM RELIABILITY, EFFICIENCY, AVAILABILITY, AND EASE OF MAINTENANCE ARE STILL PROBLEMATIC.

THE DEPARTMENT OF ENERGY SAYS IT PROPOSES TO SPEND NEARLY $204 MILLION THIS YEAR FOR RESEARCH AND DEVELOPMENT IN RENEWABLE ENERGY TECHNOLOGIES AND RELATED PROGRAMS IN ENERGY STORAGE AND ELECTRIC ENERGY SYSTEMS. THESE PROGRAMS CAN STIMULATE GROWTH IN THE USE OF RENEWABLES. CONTINUED R&D, IN CONJUNCTION WITH INDUSTRIAL PARTNERS, WILL HELP REDUCE COSTS AND IMPROVE THE PERFORMANCE OF NEW TECHNOLOGIES.

AS YOU POINT OUT, MR. CHAIRMAN, FUNDING FOR RENEWABLE ENERGY SLIPPED SHARPLY IN THE PAST DECADE. IN THESE TOUGH BUDGET TIMES, AS I UNDERSTAND, THE PRESIDENT HAS REQUESTED MORE FUNDING FOR DOE R&D IN

RENEWABLES THAN THIS COMMITTEE ITSELF AUTHORIZED IN THE "RENEWABLE ENERGY AND ENERGY EFFICIENCY TECHNOLOGY COMPETITIVENESS ACT OF 1989." THAT IS A CLEAR SIGNAL THAT THE ADMINISTRATION IS COMMITTED TO MOVE FORWARD WITH R&D IN RENEWABLE ENERGY.

RENEWABLE ENERGY HAS THE POTENTIAL TO CONTRIBUTE TO OUR "ENERGY INDEPENDENCE." I LOOK FORWARD TO HEARING FROM OUR WITNESSES TODAY ON THE STEPS WHICH WE CAN TAKE AS A NATION TO REDUCE THE UNCERTAINTIES ASSOCIATED WITH RENEWABLE ENERGY, AND MOVE FORWARD TOWARD GREATER US OF THESE RESOURCES.

Mr. **Scheuer**. Thank you, Congressman Ritter.

Congressman Dick Swett of New Hampshire.

Mr. **Swett**. It is a pleasure to be here this morning. I apologize for appearing late, but I was using mass transportation to get here and that's where I found my difficulty.

I just want to take a few minutes after I thank the Chairman for holding I think such important and necessary hearings at this critical time in our Nation's history, to say that I have had the opportunity of not only becoming interested in the energy sector, but of having practiced within that sector as a developer of alternative energy in co-generation power plants. I am extremely interested in the topic that we're going to be talking about today because of not only my own professional background there, but because of the decisions I took as an architect to gear more into my engineering background because of the philosophical underpinnings that I had identified within that sector.

As I said, I am glad to be here today to look into an issue that is near and dear to me. The renewable energy resources that this country holds I think are under-utilized, and I think they are a part of our future that the President has put an under-emphasis upon.

My experience in the private sector educated me in the way that Federal policies can be an obstacle for those working to cut down on our Nation's thirst for foreign oil. Everybody, including a chorus of voices in the current Administration, is calling for us to cut down on our dependence on foreign oil. But the only means to that end supported by this Administration seems to be to call for drilling for more domestic oil. This, I believe, is a short-term solution at best, and certainly a dangerous one at worst.

What we really need is to develop clean, safe, and domestically available energy sources that will satisfy our energy needs without destroying the environment in the process. I am not talking about pie in the sky; I am talking about technologies that could be ready for us in only a few years. All we need is a little bit of commitment to make it happen. But as I inferred earlier, the commitment is not there.

I am looking forward to hearing testimony today from this truly distinguished group of experts on these issues. I hope you will be able to give me and my colleagues some ideas as to how we can bring our research and development resources to bear on this pressing challenge.

Mr. Chairman, I thank you for this time. In closing, I would just like to add that there are several areas that I am particularly interested in hearing about. Certainly we will be discussing conservation as it relates to renewable fuel alternatives; but I would also be curious to hear about new technologies that would call upon the use of pump storage for maximizing efficiency in our current power plants across the country. With those ideas placed before you, I look forward to what I hope will be an interesting and productive hearing.

Thank you, Mr. Chairman.

Mr. **Scheuer**. Thank you very much, Congressman Swett.

Congresswoman Connie Morella.

Mrs. **Morella**. Thank you, Mr. Chairman.

Mr. Chairman, current events have revived interest in renewable energy sources. I am concerned that even with this increased incentive, the proposed budget for fiscal year 1992 for the Department of Energy's Renewable Energy Program really only contains, as you mentioned, a modest increase over last year's budget. And this is a 4 percent increase.

The Department of Energy research and development program in renewable energy sources, which are being reviewed at this hearing include: solar technologies, hydropower, biomass, wind, and geothermal. They account for 8 percent of the United States' energy supply. Forty years from today, renewable energy sources could be supplying more than 50 percent of the world's energy, according to Worldwatch Institute. The time has come to give adequate funding for research to be internationally competitive, to improve air quality, and to slow global warming.

I am very interested in hearing from our witnesses today, starting off with Secretary Davis of DOE. I know they will have recommendations for us on increasing the Federal Government's role in research and development of renewables, and offering incentives to private industry to move to renewable energy sources.

I thank you, Mr. Chairman, for this hearing. I yield back the balance of my time.

[The prepared statement of Mrs. Morella follows:]

AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S RENEWABLE ENERGY PROGRAM

CONGRESSWOMAN CONNIE MORELLA

APRIL 9, 1991

Constance Morella

MR. CHAIRMAN, CURRENT EVENTS HAVE REVIVED INTEREST IN RENEWABLE ENERGY SOURCES. I AM CONCERNED THAT EVEN WITH THIS INCREASED INCENTIVE, THE PROPOSED BUDGET FOR FISCAL YEAR 1992 FOR THE DEPARTMENT OF ENERGY'S RENEWABLE ENERGY PROGRAM CONTAINS ONLY A MODEST INCREASE OVER LAST YEAR'S FUNDING.

THE DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT PROGRAM IN RENEWABLE ENERGY SOURCES, WHICH ARE BEING REVIEWED IN THIS HEARING, INCLUDE SOLAR TECHNOLOGIES, HYDROPOWER, BIOMASS, WIND, AND GEOTHERMAL AND ACCOUNT FOR EIGHT PERCENT OF THE UNITED STATES ENERGY SUPPLY. FORTY YEARS FROM TODAY, RENEWABLE ENERGY SOURCES COULD BE SUPPLYING MORE THAN 50 PERCENT OF THE WORLD'S ENERGY, ACCORDING TO THE WORLDWATCH INSTITUTE. THE TIME HAS COME TO GIVE ADEQUATE FUNDING FOR RESEARCH TO BE INTERNATIONALLY COMPETITIVE, TO IMPROVE AIR QUALITY, AND TO SLOW GLOBAL WARMING.

I AM INTERESTED IN HEARING FROM OUR WITNESSES TODAY. I KNOW THEY WILL HAVE RECOMMENDATIONS FOR US ON INCREASING THE FEDERAL GOVERNMENT'S ROLE IN RESEARCH AND DEVELOPEMNT OF RENEWABLES AND OFFERING INCENTIVES TO PRIVATE INDUSTRY TO MOVE TO RENEWABLE ENERGY SOURCES.

Mr. SCHEUER. Thank you, Congresswoman Morella.

We will now go right to our first witness, Assistant Secretary Michael Davis, Assistant Secretary for Conservation and Renewable Energy, of the U.S. Department of Energy. Please take six or seven minutes, Mr. Davis, and summarize your views. Your full prepared remarks will be printed in the record. Then I am sure we will have some questions for you.

STATEMENT OF J. MICHAEL DAVIS, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE, ENERGY U.S. DEPARTMENT OF ENERGY, WASHINGTON, DC

Mr. DAVIS. Thank you, Mr. Chairman, members of the committee.

Mr. Chairman, you made Admiral Watkins I think a fine and forthcoming offer in his recent appearances up here. You basically said, let's work together in a positive fashion and get on with it. I appreciate that offer, and I am happy to be here to start that. I also appreciate the remarks that you offered in introducing this hearing. We thank you for that.

Mr. SCHEUER. Let me say that I meant those remarks in a very heartfelt way, and I am positive that I speak for the entire subcommittee. Nobody is interested in rancor and nobody is interested in opening up old wounds. We want to get together in a collegial, constructive, positive, creative way and produce the kind of program for alternatives to fossil fuel energies that will get our country back on the right track. We can't do that through acrimony, we can't do that through confrontation; we can do that through reasoning together in a spirit of helpfulness and cooperation. And I am positive I speak for the entire committee, both sides of the aisle, when I hold out the hand of friendship to you and express the great wish that we can work together in that fashion.

Let me just add that I have known Secretary Jim Watkins in several of his prior reincarnations. I consider him one of the outstanding public servants that I have ever known in the course of 25 years in this town. He is assuredly one of the stars of this Administration. And I look forward with great pleasure to working with him and you.

Mr. DAVIS. Thanks again, Mr. Chairman.

I will just summarize my remarks. I look at scorecard basically starting 18 months ago. That's the time that we've been involved in trying to put the renewable program in a little different perspective. I think we have had some success there. Certainly we need to continue that, and we need your support to do that. Last year we proposed a budget that was 26 percent higher than previous year's appropriations. Congress reacted to that and the funding was actually 42 percent above prior year appropriations. This year our request is only a few percent higher, as you point out, but I do want to point out that within that budget we have continued to focus on and to establish priorities for what investments we can make and make effectively, and there are some substantial increases even within that overall cap.

I would also note that you have already scheduled hearings on the conservation side of our budget. At least in 1992, that is where the majority of the growth was actually placed, in conservation R&D. But we see those fitting together in a very positive way.

We changed the structure of our organization. It was basically set up as conservation, renewable, State and local programs. We changed that to build it around the end-use sectors—buildings, transportation, industry, and utilities. And I think that's a very important change, it is not just a superficial change. It changes the whole scorecard. Renewable technologies are like any other energy technology. They have certain characteristics, they have very special characteristics. You need to understand those characteristics before you can really understand their value and how to use them. So if we put those characteristics in context, we can shift the question fundamentally to I think a much more important question, which is what would it be worth if we had certain capabilities rather than focusing on a specific renewable technology—and I can give you many examples.

Let's focus on a specific sector, as you point out. What would it be worth if we had renewable transportation fuels produced at home that were economically attractive? What would it be worth if we had clean, reliable electricity from a variety of renewables that served an ever increasing portion of our electric demand? When you put it in that context, you see that the technologies are indeed extremely important to us.

Then the question becomes, okay, where are they now, what progress have we made, what remains to be done, and how do we invest in that challenge given the relationship that we need, a positive relationship between government and industry. And again with the new organization based on sectors, I think we are improving our relationship. As an example, you mentioned a battery consortium. That happened because of our focus on transportation within our part of the Department. We are looking at transportation again, not just as conservation and renewables, but we are looking at ways we can use conservation technologies to reduce the demand for any kind of energy in transportation; and we are looking for ways to use renewable technologies to produce alternative fuels that we can use again in the transportation sector to reduce dependence on imported fuel.

So we have tried to change the scorecard and the whole attempt is to put these technologies, these renewable technologies and again the efficiency technologies, in perspective so that we can figure out how to invest in them, what to expect—not to over-promote, but to put the investments in enough perspective so that both the private sector, very importantly—because we cannot appropriate the solution, we can go a long ways towards the solution; we need the leadership, and we need to send the right signal. But we need that relationship with the private sector if we're really going to solve the problem effectively and quickly. I think that is beginning to show. We have got a lot further to go, but I think in 18 months we have made important progress on that general approach.

It is also true that we learned—and this has been reinforced through the strategy process—there isn't a silver bullet. We need continued and probably very long-term contributions from all of our energy sources—coal, gas, nuclear. They are all there, they all have characteristics, again, just as any other technology. And we need not just continued contribution, we need further investment in all those technologies so that we can use them and use them in an environmentally satisfactory way.

I think the thing to point out—and this may be obvious about renewable technologies, but I think sometimes, at least from my private sector days and marketing days, it is important to state the obvious—renewable technologies as a group are not limited like any other energy technology in terms of the resource base. The limitation is technology. If we can develop the technology to use these renewables, not only do we solve important domestic problems, but in many important ways we enable a lot of the rest of the world to use these technologies. They are not bound up by geography, they are not bound up by political problems, they are not bound up by a lot of the constraints that we have with our existing energy infrastructure. So there is great opportunity as we move forward.

More specifically, in terms of different topics within our budget: We have been underway now for about a year and a half in the photovoltaic area. That is what we call our manufacturing initiative. It was a first step, it was an important step, to say we think there has been excellent progress made in the laboratory; how do we get that progress reduced to practice, how do we get that into manufactured products. And from a program point of view, we are taking an entirely new approach to focusing on the manufacturing technology development necessary to do that. We think that that is a clear opportunity for substantial cost reduction in the next three to five years. Our overall PV request is up 10 percent from last year.

In the solar thermal area, we have broadened that area just a little bit. We certainly have ongoing activities in solar thermal electric power generation, but we have also broadened it to include some important detoxification opportunities within the industrial base, both detoxification of water and detoxification of soil. We have, or will be announcing shortly, some joint projects—EPA is part of that, we are part of it, our defense weapons clean-up activities are part of it, the Army is part of it—where we are actually going to be bringing forward specific projects to demonstrate the technology.

In our biofuels area, we have increased that budget substantially. We have gone from $9 million to $20 million to $29 million, which is a fairly rapid increase in 18 months, focusing primarily on biofuels. The overall program is also up about 11 percent relative to last year's appropriations. We think there is a fundamental opportunity to add additional cash crops to our agriculture sector, which can currently substantially over-produce its market. We think we can broaden that market, we think we can do it at a profit, we think we can do it in an environmentally sensitive way, and we think we can do it on land that is not currently being used. So we think there is truly a win-win situation there. We now have a much better relationship, and it has actually been put into a formal relationship, with the Department of Agriculture to get them back involved in the energy business, get the Land Grant colleges and the young minds that are enthused about these topics involved in this technology, and we are encouraged by that.

With respect to wind energy, right now it is the most utilized solar energy technology in the power market. I think it is a bit of a secret but I think it is one of the best buys. We have some activity underway now that would hopefully facilitate the next generation of wind turbine. It is a small improvement, but to give you some example, we think we can, working with industry, accomplish that improvement with a very small amount of money and that improvement will increase by 20-fold—20-fold—the resource area for wind at competitive rates. In other words, instead of our current turbines being limited to operate only in a certain geographic area with the very best wind resources, we can expand that area 20-fold in terms of being able to produce energy from wind at competitive prices. Again, I would suggest that's a best buy.

Mr. **Scheuer**. Wouldn't that technology, if we can develop it and apply it to 20 times the area that we're applying it to now—in other words, areas that have less than the optimum wind conditions—wouldn't that be a potentially tremendous economic opportunity for American companies to be manufacturing this technology for tropical areas, desert areas, really all over Asia and Africa, the Middle East?

Mr. **Davis**. I can speak more, frankly, to the national market than I can international, and you will have some other witnesses who are certainly more expert than I am about the international market, but since in my view we are still the largest market, it is a huge potential. There is a lot of work to do. There are a lot of people that have to agree with us on that point, but I think there are a lot of things now in our favor to prove the point. I think, again, that little increment of improvement we need, we can accomplish and we can do it at a very low cost. Back to the point of some of these technologies are now in a position where they truly are worth further investment. We are not over-promising, we're not out of control, we're not in a position where we can't use the money wisely, and I think even industry will say that we have made progress in developing our relationship with the private sector, so the money is going to the right places, it is not just going willy-nilly into the system.

I will point out where we reduced the budget. We reduced the budget in geothermal energy. I would point out that geothermal energy by itself is a very bright area, because there are three primary activities within that—the hydrothermal resource, which is the current issue, and we increased our budget on that; then there are other longer term aspects to geothermal that we would like to work on but we held back in the interest of priority.

Hydropower, we are not asking for a lot of money there, but we certainly believe that the regulatory burdens of hydropower are something that have to be addressed, and we have proposals in the National Energy Strategy to do that. That goes along with some of the issues that Mr. Swett raised in terms of ways to utilize that resource.

We have increased our budget request for the whole area of electric and magnetic fields, an area that you are personally aware of in terms of your previous activity with EPA. We have supported research there for a lot of years. We think we have some contribution to make, and our budget is a 45 percent increase in that area.

I would like to conclude by calling your attention to some handouts that I believe are there in front of you with respect to the different energy technologies. There is a little cover sheet that talks about a decade of progress. I, like you, don't gain a whole lot from looking back and criticizing or wondering what if. I also have some personal scars of those changes in the last 10 years that we all went through in the private sector. But what we have tried to capture on these charts is what has happened in the last ten years to the technology, what investment has been made from the Federal side—and I want to point out that is the Federal side, that doesn't convey the whole investment. We are not trying to take credit, because that progress has a lot of shared hands. But it shows you what has actually been accomplished and you can see photovoltaics in 1990 are producing power at somewhere between 25 and 40 cents a kilowatt hour. And you can see what we've spent in the decade.

Now the question becomes, OK, Davis and others, what is it going to take to move that down? What can you do, over what time frame, with what level of investment, and what relationship to the private sector in terms of technology develop and, very importantly, what can we do in terms of the market conditioning activities—which may be incentives, which may be removing regulatory burdens and barriers that already exist. It is not just R&D, we need both a technology push and a market pull to make this happen quickly. But the question is, and I think it is an important one, what does it cost to make further progress.

You can see the solar thermal chart. You can see that we are down under 10 cents, actually without any investment tax credit provision we are just over 10 cents in terms of true cost for solar thermal electric. But you can see what the curve has done in 10 years. Then you can project again what the future cost and benefit would be of continuing the development of that technology.

You can see where we've come in biomass. I think some of the performance there has been startling. And we do have the ability to produce ethanol from corn and we can make that process much better. Today, that's a little less than 1 percent of our total liquid fuel requirement. We might be able to triple or quadruple that without any effect. But we are asking for much more, and we think there is much more potential. We think there is potential to go to 20, 30, 40, or 50 percent of our liquid fuel requirements overtime, and do it with continued, focused, government-supported research and market conditioning.

Wind, I mentioned that wind is one of the best buys. If you look at what we've spent over the last 10 years, $243 million, you look at where wind is today in terms of what power it is producing, the reliability and the maturity that the industry has shown in terms of fixing past problems, then move that forward and the cost to move that forward, we think that is a very reasonable investment.

And the last chart is on geothermal. It shows what we have spent in the last 10 years, $434 million. It shows where current costs are. That's the lowest current cost from this form of renewable; certainly not hydropower, but from geothermal in terms of cost per kilowatt hour. And, indeed, there is opportunities for improvement there. The question is how, at what cost, and when.

So, Mr. Chairman, I would offer you certainly enthusiasm from our side. Again, I want to thank you for the offer you made; I think it is exactly right. I would be happy to answer any questions you may have. I think we are very well positioned to move forward, and that's encouraging from our side of it.

[The prepared statement of Mr. Davis follows:]

Statement of J. Michael Davis
Assistant Secretary for Conservation and Renewable Energy
Department of Energy

before the

Committee on Science, Space, and Technology
Subcommittee on Environment
U.S. House of Representatives
Tuesday, April 9, 1991

Mr. Chairman and members of the Committee, I am pleased to present the Administration's Fiscal Year 1992 budget request of $204 million for Renewable Energy programs.

Last year, in a notable departure from recent history, we proposed a budget that was 26 percent higher than the previous year's appropriation. Congressional action resulted in FY 1991 funding that was 42 percent higher than in FY 1990. This year's request is only 2 percent higher than last year's appropriation, but as evidence of our sharper focus, you will find some significant increases imbedded within that number.

In addition, we have reorganized the Office of Conservation and Renewable Energy. The office was previously divided between Deputy Assistant Secretaries for Conservation and Renewable Energy, plus an Office of State and Local Assistance Programs (SLAP). The new organization is built around the four end-use sectors -- Buildings, Industry, Transportation, Utilities -- and an Office of Technical and Financial Assistance. These sectors represent our customers. Our intent is to make our programs more market- and results-oriented, bringing supply and demand issues together in ways that make internal management and external communication easier and more consistent.

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OVERVIEW

Renewable energy -- energy from sources that naturally replenish themselves, such as rivers (hydropower), sunlight (solar energy), growing things (biomass), and the heat of the Earth (geothermal energy) -- inherently has three very important advantages:

- While its separate components are all limited in one way or another, collectively it offers a diverse and virtually inexhaustible resource for the Nation's energy needs.
- The production of energy from renewable sources is generally substantially less harmful to the environment than from conventional sources.
- As a largely domestic resource, renewable energy can contribute significantly to our economic and energy security.

But its enormous potential has not yet been realized because of economic, regulatory, and technological constraints.

We learned from the National Energy Strategy development process that no one technology is going to provide a "silver bullet" for our energy needs in the coming years. We are going to need major contributions from oil, gas, nuclear, coal, and improved energy efficiency in addition to renewable energy, but renewable energy has enormous promise for clean and abundant domestic energy supplies. Hydropower, biomass, and waste-to-energy technologies are mainstream contributors, and wind, geothermal, and solar thermal facilities are becoming increasingly viable. The intent of our efforts is not to select favored technologies, but to accelerate the commercialization of promising technologies that may compete in the energy market. This will facilitate the provision of adequate, reliable, and environmentally sensitive energy resources at competitive prices.

Taken as a whole, renewable energy is not resource-limited: The size of the resource is orders of magnitude larger than our foreseeable demand. Instead, it is technology-limited: That is, we have not yet developed several of the technologies to the point where they can compete in the marketplace without subsidy for widespread applications. Other limiting factors are relatively high capital costs, the intermittent character of some renewable energy resources, the geographical limitations of the highest-quality resources, and the perceived risk of emerging technologies. Additionally, a variety of regulatory constraints, ranging from complex and expensive licensing procedures to local zoning codes, tend to retard the full utilization of renewable energy resources.

These impediments to the increased use of renewable energy are addressed in the National Energy Strategy. Action by Congress on the proposals contained therein, together with regulatory and other pressures on utilities, will lead to new market opportunities for renewable energy technologies. Our challenge now is to ensure that the technologies are ready to seize these opportunities through a vigorous program of research and development.

Now let me touch on some of the key points of our budget request.

SOLAR ENERGY

Last year we embarked on a project within the Photovoltaic Energy Systems program to identify and resolve barriers to mass production of photovoltaic cells, attempting to move the very significant progress we have seen in the laboratory to the production line. A better, less expensive product will result, leading to increased commercialization. We have cost-sharing agreements in place with more than 20 companies to define generic manufacturing problems impeding scaleup. The next step will involve a smaller number of follow-on contracts to identify specific solutions. Our request for this Photovoltaic Manufacturing Technology (PVMaT) initiative is $12 million, up from $9 million. The overall PV request is $50.8 million, up from $46.3 million appropriated last year.

Within Solar Thermal Energy Systems, we have a promising application of solar thermal technology for the destruction of hazardous chemicals. Solar detoxification, using a low-temperature, catalytically assisted process, completely destroys volatile organic compounds and other contaminants, producing carbon dioxide, water, and easily neutralized acid as its end products. This year we will conduct a field experiment on the process at Lawrence Livermore National Laboratories, in conjunction with the Department's Office of Environmental Restoration and Waste Management. Additional work on the catalysts and solar reflectors should reduce the process costs. The overall Solar Thermal request is $20.0 million, up from $19.3 million appropriated last year.

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BIOFUELS ENERGY SYSTEMS

The largest piece of our work in Biofuels Energy Systems involves the conversion of "energy crops" -- non-food biomass feedstocks -- to ethanol and methanol for use as alternatives to gasoline. Our request in this area is for $29.4 million, up from $20.7 million in FY 1991. Our aim is to produce fuels that compete with gasoline without the need for a subsidy. An in-depth analysis that we performed with the Agriculture Department found that with continued technical progress we could replace as much as half of our current gasoline use with biofuels by the year 2030 with little impact on food prices.

The importance of this effort for reducing our dependence on imported oil is obvious and especially significant at this time. The use of alternative fuels from biomass also would reduce fossil fuel combustion and thus carbon dioxide emissions. In addition, increased production and use of biomass could provide an economic stimulus for rural America, creating another cash crop for farmers and a major new industry for the Nation's heartland.

The biofuels conversion research at the Solar Energy Research Institute (SERI) has reduced the estimated production cost of ethanol from biomass to $1.35 a gallon (from $3.60 in 1980); the program goal is to reach $0.60 a gallon by the year 2000. Our major need at this time is for integrated process testing, to lay the groundwork for scaling up the process. The budget request for design and construction of a process development unit is therefore critical to the program's research path.

We have reduced the funding for feedstock development from $5.1 million to $3.0 million in anticipation of an increased level of effort at the Department of Agriculture. We have entered into a Memorandum of Understanding to coordinate our work in this area, and we expect USDA to pick up and accelerate this very important long-term research into fast-growing cellulosic crops.

The feedstock research will also assist in increasing the use of biomass for electric power generation. We are increasing our effort on thermochemical conversion of biomass to a gasified feedstock for use in an advanced, high-efficiency turbine. This concept has potential efficiencies comparable to those of advanced fossil fuel cycles. The overall request for Biofuels Energy Systems is $36.8 million, up from $33.1 million appropriated last year.

WIND AND OTHER SOLAR ENERGY

Wind energy has proven to be the most utilized solar energy technology for the bulk power market, with over 1500 MW installed in the U.S. (mostly in California). Extensive field operating experience accumulated on commercial machines over the past six years has shown that major problems remain to be resolved in the areas of turbine structure and component fatigue, costs need to be reduced, and performance needs to be improved for the technology to be fully competitive at lower velocity wind sites (12-14 mph) in broad domestic and international markets.

Results to date indicate the potential for major advances in weight and energy capture, cost of wind turbines, and machine reliability. Current machines cost $1100/kW and produce power at $.06-.08/kWh in 14-16 mph wind sites, which represent about 0.3% of the developable land area in the contiguous United States. Anticipated new machines would cost $950/kW and produce power at $.04-.05/kWh in 13 mph wind sites, which would expand the developable land area to 6.2% (more than a 20-fold increase). Our budget request for Wind Energy Systems is $13.9 million, up by 26 percent over last year's appropriation, including $4 million for a cost-shared advanced wind turbine development program involving both utilities and system manufacturers.

We are requesting no funding for Ocean Energy Systems. Our work to date has furnished industry with a data base that can assist in the commercialization of these technologies. In our judgment, additional activity is not justified on the basis of cost and potential benefit.

With regard to Solar International Programs, our budget request includes funding for the interagency Committee on Renewable Energy Commerce and Trade (CORECT) at last year's level of $1.5 million. CORECT has been an active and valuable aid to the renewable energy industry in expanding its export base. In addition, the recent creation of the Office of Export Assistance in the Department's Office of International Affairs and Energy Emergencies will improve all DOE export promotion efforts by bringing oversight activities together into one office which has visibility and access to high-level decision makers in other agencies and other governments.

Finally, Congress last year supported our request to begin work on a new laboratory building at SERI, replacing leased space that was originally built as an office building and that can no longer support photovoltaics and related materials science research. The new $20 million facility will allow for improved handling of hazardous materials and reduced vibration for critical optical measurements. An A&E firm has been selected to develop a design, with approval expected in April. Construction is scheduled to begin later this year. The FY 1992 request for this important facility is $10 million.

GEOTHERMAL ENERGY

Our budget request for Geothermal Energy, at $20.2 million, is 26 percent less than last year's appropriation and reflects a balancing of our priorities in a period of fiscal constraints. We are concentrating our research on better understanding and more rapid development of hydrothermal resources, with a special effort targeted at the steam reservoir at The Geysers in California. This is the highest priority of the industry.

Development of geopressured resources is considered less likely to be cost-effective in the near term, and accordingly, our request is substantially reduced in this area. However, as part of the Department's omnibus FY 1991 reprogramming package, we will ask that $5 million be shifted from assessment of the geothermal resource in Hawaii, where a State geothermal project has become embroiled in controversy, to testing of the geopressured resource at a deep well in Louisiana. This is an important opportunity to greatly improve our assessment of the geopressured resource.

HYDROPOWER

As we noted last year, the National Energy Strategy hearings, together with interactions with industry and the Federal Energy Regulatory Commission (FERC), indicated a time-consuming, costly, and overly complex licensing and permitting process for hydropower, with duplicative environmental reviews and overlapping layers of jurisdiction.

Since 1960, the number of laws and decisions pertaining to hydropower license applications has grown from 2 to 19. The number of agencies that can veto a FERC licensing decision has grown to 7. Over the past decade the average time consumed in the licensing process has increased from approximately 1 1/2 to 5 years. These factors threaten the health of the industry.

Our analyses suggest that about 23,000 MW of additional hydropower capacity could be developed by the year 2030. To encourage development of that capacity, the National Energy Strategy proposes several options for regulatory reform. In addition, we will research and analyze relevant environmental issues, with the goal of developing uniform criteria and procedures for evaluating hydropower projects. We have collected cost/benefit and effectiveness data on environmental mitigation practices at 200 hydro projects for analysis. We will also develop methodologies for evaluating the societal and environmental costs and benefits of hydropower. The budget request includes $1 million for these efforts.

ELECTRIC ENERGY SYSTEMS AND ELECTRIC STORAGE SYSTEMS

Nationally, we lose about 10% of the total electrical energy we generate in the transmission and distribution grid. High-temperature superconductivity (HTS) may one day eliminate many of these losses and lead as well to highly efficient generators, storage devices, and motors. The FY 1992 budget request for Electric Energy Systems continues our support of the highly successful HTS Pilot Centers, which promote cooperative R&D projects with the private sector in this area. The overall request for Electric Energy Systems is $30.7 million, up from $28.0 million appropriated last year.

The budget request also includes a 45 percent increase, to $5 million, for research on the potential health effects of electric and magnetic fields. DOE has been leading the Federal effort on this important topic for more than a decade. It is an area of mounting public concern and controversy and should be investigated aggressively.

Finally, the budget for Energy Storage Systems shrinks by 43 percent from its FY 1991 level, from $12.7 million to $7.2 million. This reflects the consolidation of our battery development work for transportation within the Energy Conservation account. The Energy Storage program traditionally performed some of the more basic battery R&D for the Conservation electric vehicle program. The proposed restructuring will facilitate our work with industry. As you may know, the three major U.S. automakers recently formed a consortium to work with the battery industry, electric utilities, and DOE to develop advanced batteries. Within Energy Storage Systems, the research program now focuses on advanced utility load-leveling batteries, seasonal thermal storage in aquifers, and improved conversion and storage technologies for hydrogen.

SUMMARY AND CONCLUSIONS

Mr. Chairman, this brief review touches only lightly on our budget request for FY 1992. We are asking for increased funding for renewable energy research and development, but more importantly, we are focusing our request on the most important opportunities before us. The National Energy Strategy lends additional support for our efforts, particularly in the area of alternative transportation fuels. Our goal is to produce additional energy resources for the Nation that not only contribute to our security and our environmental quality, but that represent the most cost-effective options competing in the marketplace.

I appreciate your time and attention, and I would be pleased at this time to answer any questions you may have.

Thank you very much.

Mr. **Scheuer**. Thank you very much, Mr. Secretary. I look forward to working with you in a friendly, cooperative way. And, in view of that hope, I am going to defer the opportunity of raking over the history of the last 10 years. I really don't want to get into that because I fear the consequences in terms of the good will between us. Therefore, I am going to obliterate the last decade from my consciousness.

Congresswoman Connie Morella.

Mrs. **Morella**. Thank you, Mr. Chairman.

Renewables have been around for a long time. There is nothing really new about them except we hope that now with the National Energy Strategy, Mr. Secretary, we are going to be making some major strides. You come off as pretty optimistic about the amount of funding. The increase, although it is modest, you can see a real direction. That's good to hear. But from what I have seen of the Department of Energy's forecast, renewable energy sources are likely to provide only about 9.5 percent of projected U.S. energy supply in 2000, and 12 percent in 2010, compared to about 7.5 percent today. Yet, there are others who say that that is much too modest a goal and that we really could and should be doing more.

On top of that, DOE spends more each year on nuclear fusion, superconductor supercollider, fossil fuel R&D—on each one of those three items that I mentioned, more is spent than on all the renewable energies combined. Would you comment on both of those? Are we moving fast enough really? And, secondly, how do you justify putting so much money into each of those other areas than the whole area of renewables together?

Mr. **Davis**. Well, again, Mrs. Morella, to go back to what I tried to say initially, I think if you look at energy broadly, what it amounts to is a whole bunch of very powerful interests and those interests have for a lot of years been basically allowed to operate independently. We figure out what we want to do for oil and for gas and for coal and for nuclear and for renewables and for whatever. Then we somehow bolt that together and that's our aggregate investment. But as some of the signs of that approach begin to bother us and we bump up against the real limits of resources to apply against it, then we have to start making choices. I think every Assistant Secretary, every company president, every worker, if you will, that is installing systems—and I, thank goodness, had some experience in each of those—would assert that this particular opportunity is the one and it should be funded at substantially greater rate.

I could assert that for all my technologies, and I don't think it would do me a lot of good. What I can do for the technologies, and what I will continue to do, is to go back and say, wait a minute, let's put all these investments in perspective. Let's build a base, let's try and show what the costs are and what the benefits would be, and let's do it uniformly. Let's not let any one of these technologies approach the bench, so to speak, for appropriations without putting their opportunity and their cost in context.

Now I believe that when you take renewable energies, as you've mentioned, and you put them in competition with any other energy technology that you all can invest in, and you do it by sector, and you do it by supply and demand and by time frame, that we will increase our share of whatever is available. And that's my commitment is to continue to do that homework so that these investments can be put in much better perspective than just an assertion that we ought to do more. There is reason to do more, and I think we can justify it.

Mrs. **Morella**. So, basically you are saying we are going to move together, collectively, with all of the renewables, knowing that we want to increase it, and what had happened with some of the other sources has happened. You are going to deal with your own turf, your own area, moving ahead.

You also mention that renewables are technology driven. Is there more that we can—you seem somewhat satisfied with the progress we are making with the technology. Is there more that we could do, and would extra funding help?

Mr. **Davis**. I think it would. I mean, there is no sense in avoiding that question. But it does have to be taken in context with the other investments, which I am willing to do. And I will support the decisions as made. But as we continue to get smarter, and we probably know more about what we would propose this very day than we did when we sent our budget to OMB and so forth, and we are going to continue to build our justifications so that both the Administration and Congress can see better than they have in the past the benefits of these investments. I believe if you can see that, then we will eventually get the adjustments, we will eventually get the funding where it will produce the best good.

I can also point out areas in other technologies. I can point out areas in coal and gas and nuclear that probably are underfunded relative to other activities that I might think are overfunded.

Mrs. **Morella**. Do you see a role for tax credits, in terms of providing incentives for further development in the renewable industry?

Mr. **Davis**. I absolutely do. I don't think—I would say also that past history, the 1970's and the 1980's, have proved that a single tool won't do it. I mean, if your only approach is the market incentive and the technology isn't ready, we know what problems that got us into. And if the only approach is "just research," and there is nothing to work that very complex market that has already got all kinds of biases in it, that won't be necessarily successful either. It takes a combination of what I call both technology development, which we are pretty well positioned for, and market conditioning. And we suggested some of those approaches in the work we did for NES.

Mrs. **Morella**. You also mentioned some forthcoming demonstration projects. Could you tell us something more about that?

Mr. **Davis**. Well, we have got one project—the two demonstrations that I mentioned were in the Solar Thermal program. We have got one project where we are going to be developing a project at Lawrence Livermore Laboratory in California. That is already a superfund site and we are going to look at some solar decontamination capabilities there.

We are also working up a project with the Army. We don't have a site for that. It will be at an Army site; it may be in Oregon. But, again, that is dealing with detoxification of water in this case, looking at some of the chemicals that have polluted the ground water. In both cases, we think there is a very good chance for success.

Mrs. **Morella**. Thank you, Secretary Davis. I concur with what our Chairman said in terms of working with you and trying to move the renewables ahead quickly. Thank you.

Thanks, Mr. Chairman.

Mr. **Davis**. Thank you.

Mr. **Scheuer**. Thank you, Congresswoman Morella.

Congressman Dick Swett of New Hampshire.

Mr. **Swett**. I will start out by concurring also. I hope to be able to work in a positive manner with you.

The one thing that frustrates me so much about this whole subject is that neither DOE nor the Administration nor Congress has been able to make this into a sexy issue that can garner the interest of the public. The reason I say that is that we have gone for these past decades and the only time that I have really seen any real strides being made in the alternative renewable energy field is when we have had the market force us into making those strides. When oil has gone to a high enough price, people have diverted attention away from oil technology into the renewable fuel markets. And that's something that has lead me to believe, not cynically nor without optimism, that this is still a technology that is market driven. I am pleased by the efforts that you have made in recommending to the Administration that we increase our research in this area, and I am dismayed by the Administration's refusal to recognize those pleas.

How are we going to better glamourize this technology, these fuel sources, in order to capture the interest of the American public and educate them to the real value on the long-term of incorporating these kinds of technologies and fuel sources?

Mr. **Davis**. Well, sir, I think——

Mr. **Scheuer**. Would my colleague yield for a subset of that?

Mr. **Swett**. I yield.

Mr. **Scheuer**. It seems to me that the Administration and the President have indelibly imprinted in the American mind the costs of our dependence on Persian Gulf oil—the fact that we risked the lives of 550,000 Americans protecting our sources, our access to Persian Gulf oil. And if anything could concentrate the mind on the desirability from the point of view of our national interest in finding alternatives to continued dependence on Persian Gulf oil, certainly the experience of the last six or seven months has done that.

I am dismayed that the Administration put as little emphasis as it did on energy conservation and alternative fuels in this so-called National Energy Strategy. And I congratulate you and Secretary Watkins for having sent up to the White House for its consideration a far more thoughtful series of recommendations that were far more responsive to the real world out there and to this incredible sacrifice that we laid on half a million-plus troops in the Middle East. I share Dick Swett's dismay that the Administration didn't learn the lesson that it itself taught to the American public; namely, the gross dangers of this preoccupation with more and more fossil fuels, a higher and higher percentage of which must come from abroad.

I think one of the goals in our working cooperatively together with you, Secretary Davis, and with Secretary Watkins, is for us to create a joint program that will be responsive to those needs, that will answer the will and wish of the American public never to go through an exercise like that again in the Persian Gulf to preserve our access to Persian Gulf oil when the alternatives are clearly within our reach.

And I apologize for the interruption.

Mr. SWETT. No apology necessary. This, as you can tell, is a very passionate subject for me. I have spent years touring industry in the United States, looking at ways for them to switch off of oil onto alternative fuels and to maximize that use of that fuel through cogeneration.

I think we need to take a bigger picture. I think rather than looking at just the alternative fuel source and its regional application, whether we're talking solar, wind, or whatever, I think we also need to take a broader picture and say how are we going to incorporate this fuel into our system of use. And I think that includes the embodiment of conservation as well.

I think also we need to look at a broader picture of what our renewable fuels are. I think we have overlooked one very important source which is solid waste, which, at this point in time, is going to supply BTU power for the production of energy even though our ultimate goal is to recycle the majority of that waste stream.

So I would like to know not only—I think my first question was more rhetorical. But in this day and age where I find that realistically the technology that we are talking about really is market driven, and when you and Secretary Watkins make a very heroic and valiant effort to have that research and development budget increased in order that we get away from just market dependence and rather look more to the technology by a scientific approach on the part of the Administration, when is that really going to happen and when can we really believe that the commitment to alternative fuels and renewable fuel resources is truly going to be grasped by the Administration and then led to the public so that this country can really take into its consideration these necessary changes?

Mr. DAVIS. Sir, I don't know if I can put a date on it, but I think I can suggest some ways where things are happening and that we can be encouraged by it. Back to the larger picture, that you suggest.

I think the thing I like absolutely most about my job is that I get to deal with the supply side of the equation, and the supply technologies happen to have the characteristics I like best. We call them renewables. But I also have responsibility for the demand side for all sectors of the economy. We call that energy efficiency or conservation. Set smack dab in the middle of that is a little approach we call integrated resource planning.

Two years ago, when we were travelling around trying to create a strategy, there was very little interest in energy. The only thing driving the interests were environmental concerns. Now we have added to that. So maybe now, again, we have enough awareness. I am pleased that we have this awareness; I couldn't be happier that we have this awareness; hopefully, we can capture it.

Mr. Swett. Do you honestly think that this awareness is at a level that is going to drive the kind of funding that these programs need in order to develop these renewable fuels?

Mr. Davis. Well, I think it can, but I think there are also very important movements in the private sector that are underway and that if we are careful we can reinforce.

To continue on that thought, across the whole country, the whole utility regulatory process is trying to come to grips with how do you create rate structures such that there is a profit incentive in actually reducing the amount of power you sell, as opposed to always just selling more power. Whether it is called "least cost planning" or "integrated resource planning," we are actually seeing public utility commissions change the process, not because there is an evil empire—we've built the supply side of the equation for 90 years, it has served us well—but over that time we have built up a regulatory and tax policy structure that really took away investments in demand side. Now, when the State PUCs change that, and they are changing it in many cases with very positive coalition support from both utilities and—for instance, New England Electric and Conservation Law Foundation, Pacific Gas and Electric and National Resource Defense Council. All across the country, there are examples of where that equation is changing. We're allowing large sources of capital—and read that electric utility industry—to make a profit on the demand side. And also as they look about acquiring resources in the future, to put value on those environmental externalities that are very difficult to come to grips with from a prudency point of view.

Now, I think that's great for efficiency because there is a profit incentive and you are seeing billions of dollars starting to flow to those technologies. I think it is also great for renewables because, again, of the characteristics and the environmental benefit that these technologies bring as utilities acquire them. Plus, they can acquire them at incremental levels that are much easier to bite off than 1,000 megawatt chunks. So that electric utility process, driven by State PUCs, and hopefully coupled with the right kind of incentive signal—and we did propose what I call a "renewable production incentive," that is quite different from an investment tax credit, that would be available to the electric utility industry as an incentive towards the production of clean, reliable electricity.

Mr. Swett. Could you look at the implementation of a conservation tax credit that keys into the very nature of the fact that if this technology is employed in such a way—I'll give you one example. Whenever a renewable energy facility, whether it is a solid waste incinerator to electricity or biomass or some kind of process that encompasses both the thermal and the electrical generation process is involved, if there are incentives to make sure that all BTUs captured in that process are utilized at both ends, whether in the production of electricity or in the production of thermal load, that there are incentives to help that kind of facility maximize its profitability. Is this some approach that the Administration would look favorably upon?

Mr. Davis. Let me comment first on the production incentive for conservation approach. That is certainly something that we can look at. I don't think we've looked at it enough. But I would say this with respect to the whole topic of an incentive there, once the regulatory process has been changed so that a utility can actually earn a profit, there are ample technologies available to earn very good profit in the market today. So we think in terms of relative health, that's a regulatory change and a lot of that will happen.

Now with respect to the renewables side, and this gets back to a question that Mrs. Morella asked that I didn't answer very well, if you look at the contributions in the National Energy Strategy, they might be conservative, and I think being conservative is okay, but the numbers that you address really are comprised of only two resource types—municipal solid waste and hydropower. In those contributions, it was really just those two technologies. So we are being very, very, very conservative about what the contribution will be from the rest of the portfolio, if you will. We think that the rest of the portfolio, if we can continue to make progress, will contribute more but we weren't in a position to actually say how much at that point in time.

So we made a big statement about 3.5, almost 3.6, quads that we are going to get from municipal solid waste. We have said for about a year and a half that there is an opportunity there, that those plants can be operated and can be cleaner than any other plant that is around, that we want to look at that very carefully. We didn't want to mandate in advance required recycling, we think it is better to let the industrial businesses decide as to what they can recycle, what they want to burn, and burn it in a way that is very clean, very positive. That is a huge resource. And it is a resource that I think we can burn properly.

I think it is also an important opportunity for the liquid fuels market, because there is a fair amount of municipal solid waste that we believe we can convert to ethanol. That is technology development but it is also trying to keep ahead of regulatory policy that might preclude it. We are working now I think in a more positive way with EPA to do that, that we don't foreclose an important option that you're pointing out here.

Mr. Swett. Mr. Davis, I would like to just close in saying that I think we share many very similar approaches. My main concern, as I stated earlier, is that the public I do not feel yet has a hold of the implications that renewable resource fuels really represents to this country's security, let alone its energy picture. And I would encourage you and your Department and the Administration to take a leadership role in helping use the events of the Persian Gulf war to garner and direct the public's attention in that direction.

I also, as I said earlier, commend the work that you've done in trying to obtain the budgets for the research. You've got to work harder. We need to carry on this research because this is the future I think of this country. I believe that this is an approach that has to be wrestled with and it has to be ultimately dealt with.

I think on the regulatory side, we need to look at these facilities in a more complete manner whereby we are trying to ensure that they can operate profitably and meet all the environmental requirements that our society now holds dear and expects from its industry, and I think we can do that by focusing on the conservation aspects. And there are incentives that need to be implemented that ensure that the projects can stand on their own two feet but that they will operate efficiently, effectively, and meet the kind of conservation requirements that our social fabric requires at this point in time.

It is a complex issue, and I am here to help you and I hope that we can work together on this. I encourage you to take as broad a view of this as you possibly can. And if there is anything I can do to help, I will be more than happy to be there to assist.

I thank you, Mr. Chairman, for my opportunities to question our witness, and I yield the remainder of my time.

Mr. SCHEUER. Thank you, Congressman. Your background and experience has been a tremendous resource for this subcommittee and we look forward to tapping your expertise.

Congressman Mike Kopetski from the State of Oregon.

Mr. KOPETSKI. Thank you, Mr. Chair.

Mr. Davis, I want to welcome you to the committee. I had the opportunity to review your testimony. I get very frustrated, however, when I come back to the issue of the National Energy Strategy. Part of it is because of the Administration's near total disregard for the element of conservation as part of the Strategy. I come from the Northwest where it is a matter of course in our Northwest regional planning process. So this part of the Strategy is very frustrating to me.

The other part I guess is we just had filed last week in our State another petition, a referendum to the voters to shut down the Trojan Nuclear Power Plant in our State because the nuclear power industry still has not come up with a solution to the waste disposal issue. And I come back to the fact that a cornerstone of the Administration's Strategy is nuclear power. They think they are going to site 110 nuclear power plants in this country, and you are going to be lucky if you site 5. So you take out that part of the Strategy, regardless of what you think of nuclear power isn't the issue, it isn't going to happen. So you have to say to yourself in reality what is going to happen.

I am new and I am sitting in an agriculture committee and there is one witness who has a 2600 dairy cow farm operation up here in Gettysburg. And cows make two products—one that we enjoy very much, and the other is an environmental problem. And this guy has got one of these digestors that generates enough electricity to not only run his farm operation from the manure, but he sells the excess power to the local utility district. My farmers out in Oregon, the dairy farmers, they are in serious trouble, and now they are wondering if their cow manure isn't worth more than their milk.

But the problem is in the same hearing we had these folks from Tilamuck, Oregon, which is one of the great dairy regions of Oregon, they didn't know that this guy has already developed the technology, he's worked out all of the bugs, and figured out how to deal with this environmental problem that he has and make money off of it, with the Federal Government sitting in between saying how do we apply existing technologies, literally, on the farm. And that's really my question. When are we going to take the technologies that we have developed over the 15 or so years and literally put them on the farm? How do we help the farmers in Tilamuck understand that it exists, that you don't have to reinvent the wheel, that we ought to spend our limited dollars in these kinds of fashions?

Mr. DAVIS. Well, there is a lot of technology available to us. I mean, I can think of warehouses that I used to own and wondering what I was going to do to get that technology in one of my customers' hands. So, reflecting on what the Federal Government can do, things have been pretty quiet. We have focused on technology development for a number of years. Now what we are realizing is that there is really a great amount of communication and sharing of knowledge and experience that really needs to be done. It is a kind of activity that hasn't fared well in previous budget requests. We hope it will fare better.

I will give you one example, our Regional Biomass Program, which is an outreach program that can share a lot of this information from positive experiences, and here's how somebody is doing it here, do you know that. I would share that just within the last couple of months that ten support offices that were part of the Department of Energy's activity really were allowed essentially to atrophy over a number of years, working the conservation grant programs only, now do report to me. We are going to use those as outreach, we are going to use those both to find customers and get information to people.

So there is a large information and technology transfer job that has to be done. The Admiral has recognized that. He has tried to put emphasis on it. We are going to request, to the extent we can, budgets in those areas. And it simply points to the need that there is a lot more to do than just research and technology development.

Mr. KOPETSKI. Thank you. Thank you, Mr. Chairman. I yield back the balance of my time.

Mr. SCHEUER. Thank you very much.

Before I yield to Congressman Sid Morrison, who has just joined us, in connection with your last answer, let me ask you briefly if you feel that the information and technology transfer job is an important one, how come you cut by 75 percent—from $2.2 million to $512 million [sic]—your request for solar technology information programs and the inquiry and referral service? How come you cut ability to get the word out by three-quarters?

I must say that you say in your budget request that people, farmers, whatnot, can rely on services at the State level; I mean, we have 50 States with widely varying abilities to cope with this highly technical information. Doesn't every shred of logic scream at us that the place to put the business of technology transfer and information about very technically challenging and puzzling projects and information, doesn't logic cry at us that that is a Federal responsibility and that we shouldn't shuck that off on 50 States?

Mr. DAVIS. I assumed, Mr. Chairman, somebody would ask me that question. What we've done, we made a proposal—we have really three information outreach programs: there's a Solar Thermal Information Program, I believe STIP is the acronym; there is Careirs; and then there is one other—and we made a proposal to take those three and within our Technical and Financial Assistance part of our organization to consolidate all of that. We believe that in that consolidation we could get not just more efficiency, but substantially more outreach. So part of our outreach activity is——

Mr. SCHEUER. Look, please, time is very short. We have seven more witnesses. I really want to terminate this. I am asking you a specific question.

Mr. DAVIS. There's almost $2 million in our conservation budget for these activities.

Mr. SCHEUER. Why did you request a 75 percent reduction in your own technical information and inquiry and referral service? If you could give us a brief answer.

Mr. DAVIS. We are consolidating those. We have requests to support that activity in our conservation budget, as well as this piece in our renewable budget. So there are two numbers you have got to add together to see what our effort is.

Mr. SCHEUER. But the total numbers have been cut by 75 percent.

Mr. DAVIS. I don't believe the total numbers have. The number in the renewable side has been, that's correct.

Mr. SCHEUER. Well, you've cut your budget from information from $2.2 million to $512 thousand. A mere pittance.

Okay. I am not going to dwell on the past. We are going to work together to remediate some of these black holes that we see in your program.

Congressman Sid Morrison from the State of Washington.

Mr. MORRISON. Thank you, Mr. Chairman. I am sorry, but the red-eye from Seattle just arrived at this hour of the morning.

I wanted to make sure that the Committee——

Mr. SCHEUER. You took public transportation.

Mr. MORRISON. Public transportation, yes, sir.

Mr. SCHEUER. That's been a problem with several of our——

Mr. MORRISON. I just wanted to assure the Subcommittee, since I have had the privilege of dealing with Mike Davis at various subcommittee levels, he's one of the bright new stars in the Department of Energy. I think, Mr. Chairman, as the relationships between the Subcommittees change, you will find this will be one of the people who can make things happen down in the Forrestal Building. He also, by the way, is from Speaker Foley's district.

Mr. SCHEUER. Congressman, I made it very clear that we are not going to rake over the past in this committee. To the extent that we have to look at the past, it is going to be with great reluctance. We are going to work cooperatively and in a very constructive open-handed fashion. And I spoke for all of the members of the subcommittee, majority and minority, that we look forward to a very constructive and cooperative and collegial relationship both with Mike Davis and with his boss, the Secretary Jim Watkins.

Mr. MORRISON. In your style, Mr. Chairman. Thank you. Maybe the only important thing about Mr. Davis' past is that he grew up in the great State of Washington and has roots in Mr. Foley's district.

Mr. Davis, I wanted to address my question to sort of a combination of the fact that we ran an authorization bill through last year and then, to our marvelous surprise, found that here was an activity on renewable energy within the Department of Energy that was going to exceed what we even thought in this committee was appropriate. I wanted to ask how that related to two different things. First of all, you have gone through a restructuring of the Office of Conservation and Renewable Energy, and I presume that has had an impact on the budgetary process. And, also you had 11 new initiatives for conservation and renewable energy. I wondered if you could comment both on the restructuring and on the 11 initiatives, and how they relate to the budget process that we're looking into today. In other words, adequate funds from your point of view? Where can we help?

Mr. Davis. Let me address first the authorization levels. There are some areas now where we are exceeding authorizations. We are assuming that that's a pretty easy fix. I don't know whether there is a right number; maybe no number is the best approach in terms of Appropriations need to be appropriate, given the opportunity and the return on the investment.

With respect to our 11 initiatives. What we tried to do in January of 1990 is to say the same approach, take a positive approach. We can't complain about the past. Let's try and look within our own resources at where the best opportunities might be and focus some of our own funds on those resources by a reprogramming. And that if we made that effort, then we had every reason to expect that OMB would not be made to feel like all we were doing was asking them for more money, and that Congress, in turn, would also not be made to feel that all we were doing is just asking somebody else for more money. We tried to put our house in order first. All those 11 initiatives may not be carried specifically by their titles, but all of them are reflected in our 1992 budget request, and all of them still have high priority and share that high priority within the other investments in the program.

The first one, as an example, the Photovoltaics Manufacturing Initiative. That's $12 million out of our total of $50 million or so in the photovoltaic area.

Our biofuels activity, that's $19 million out of a total of about $36 million with respect to the overall biomass activity, just for ethanol. We think that's pretty well taken care of.

The activities we have got underway for municipal waste, we have got a couple of solicitations out and we are about to sign some contracts. We don't think that costs all that much money because it is really trying to produce data, get the facts out. So we think that is adequately covered in our request.

Across the board, I believe that we have preserved what we think are the importance of those initiatives within our 1992 budget request. Even though the total request didn't go up much, there are still increases of a far larger magnitude for those specific initiatives.

Mr. Morrison. What if we expanded that slightly?

Mr. Davis. Well, we think that our house is in order and we think we have a pretty good view of what we can do and what the benefit of these technologies are without over promising, without risking getting out of control, so to speak. We think we're in a position for sustained growth and that we can return to the Congress good benefit for that investment.

Mr. Morrison. I think one of the things that our Chairman of this Subcommittee and others are going to push aggressively for will be to take on our task of authorization. So, hopefully we can coordinate with you so that what we authorize will be maybe beyond what you feel you need to ask for within the budgeting process.

I also would like to have this record for this Subcommittee show the absolutely marvelous coordination between your office now and U.S. Department of Agriculture. I sense that has not happened in the past. And, particularly, as my colleague's question from Oregon, as we look at the potential use of America's marvelous ability to produce farm products and you to convert them into alcohol fuels, that coordination between those two agencies is absolutely essential.

Thank you, Mr. Chairman.

Mr. **Scheuer**. Thank you, Mr. Morrison.

We are running way behind, Mr. Secretary. So I am going to ask you several questions by mail just to complete our hearing record. But there is one question that I want to ask you, if you would be kind enough to respond very briefly, and this relates to the whole question of electromagnetic fields. I am sure you are quite familiar with this area. What is your department doing to bring some rationality into this area? Are you funding any work in the area of engineering controls or designs, retrofitting existing systems, or trying to cope with the business of electromagnetic fields without vast rebuilding of our entire national energy grid? Is any work being conducted jointly with the DOE Office of Health? There seems to be a serious health question. Can you tell us in a nutshell what are you doing. What is your entry into this problem area likely to be?

Mr. **Davis**. Yes, sir, and very quickly. We have increased—that's a budget request that is up 46 percent this year over last year. We are looking at various technological solutions to address some of the issues—refitting, better controls, etc. I want to respond to you for the record exactly what our relationship is with our Office of Health, and I will give you a more complete answer for the record.

[The information follows:]

Research on biological and health effects of electric and magnetic fields (EMF) has been supported by DOE/CE for the last 15 years. Funding has amounted to approximately $30M since 1980. Most of the known biological effects have been developed in the context of this program. DOE is committed to continue this program at an accelerated pace. Currently, DOE research is focused on biological and health effects of EMF in order to better understand the problem and put ourselves in a position to identify mitigation techniques, if research indicates they are needed. Other DOE supported technologies, such as Higher Phase Order Transmission Lines, reduce field exposure and are useful in prudent avoidance strategies. DOE work on exposure evaluation and assessment of field mitigation options is planned for FY92. The Office of Environment, Safety, and Health (EH) is mainly concerned with health, environment and safety issues at DOE facilities. Relevant programmatic material on EMF effects is shared with EH staff and coordination is maintained regularly.

Mr. **Scheuer**. We will write you a letter in which we will ask you for a breakdown between engineering R&D and health R&D at DOE, and you can respond to that plus another couple of questions.

We appreciate your testimony very, very much. You can see there is a sense of unanimity up here that we really want to work cooperatively with you and constructively with you and avoid acrimony and confrontation, and see if we can't make the work of this subcommittee and the DOE a showcase of how the Legislative Branch and the Executive Branch ought to be working together in a collegial, cooperative fashion.

Mr. DAVIS. Thank you, Mr. Chairman, and thank you members of the committee.

Mr. SCHEUER. Thank you very much.

OK. We will now hear the second panel. We are very short of time and all of the speakers and the congressional questioners will be asked to adhere to a five minute rule.

Mr. Michael Brower, Union of Concerned Scientists, from Boston; and Mr. Jonathan Becker, energy policy analyst from Public Citizen, Washington, DC.

Okay, Mr. Brower, would you like to testify first. Your prepared testimony will be reprinted in full at this point in the record, and we would ask you to adhere to a five minute statement period and then we will have some questions for you.

Mr. BROWER. Certainly, Mr. Chairman.

STATEMENT OF MICHAEL C. BROWER, UNION OF CONCERNED SCIENTISTS, BOSTON, MA

Mr. BROWER. Thank you very much, Mr. Chairman, and members of the committee. I represent the Union of Concerned Scientists, which is a non-profit, public interest firm that represents about 100,000 members nationwide. We work on issues concerning the impact of science and technology on society.

In considering the future of U.S. energy supplies, the question is not whether the United States will make the transition from fossil fuels to renewable energy, but when. We all recognize that world oil and natural gas supplies are limited. We have a lot of coal, but turning coal into gases and liquids that can be used in transportation, industry, and other applications will be expensive and perhaps damaging to the environment. Many people hold out hope for revival of nuclear power, but nuclear plants produce only electricity. Besides, nobody knows what to do with all the radioactive wastes that will be produced by the thousands of nuclear plants that would be needed.

So renewable energy sources will have to be developed sooner or later. There are many advantages to developing them as quickly as possible. They would reduce pollution and the risk of global warming. They are immune to foreign disruptions, like the take-over of the Kuwaiti oil fields by Iraq. And the money invested in renewable energy would mostly stay at home, not line the pockets of Middle Eastern rulers. Most important, resources of renewable energy are vast and almost inexhaustible. For example, solar collectors covering less than 1 percent of U.S. territory, about one-tenth the area devoted to agriculture, could make more energy available than the United States consumes in a year.

Those who think that renewable energy sources are still too expensive should look at the most recent data. The costs of renewable energy technologies have declined dramatically in the 1980s.

Among the technologies now ready for broad application are wind power, solar thermal power, conventional geothermal power plants, passive solar building designs, and solar hot water heating.

Several emerging technologies also look very promising. Advanced geothermal technology, such as hot dry rock, could produce heat and electricity at a reasonable cost almost anywhere in the country, not just near hot springs. Advanced biofuels, such as ethanol, methanol, and syngas derived from wood and other energy crops, could be cost competitive with gasoline and natural gas by the turn of the century. In the long-run, hydrogen generated from solar electricity and water could power automobiles, industries, electric power plants, and buildings. This does not mean that there are no problems with these technologies, but in general, in our view, these problems can be surmounted with relatively modest effort—modest, at least, on the scale of what the Nation's scientists and engineers have accomplished in the past.

If everything looks so rosy for renewables, then why is Government leadership needed? Why not let the free market run its course, which was the policy of the Reagan Administration during the 1980s? In the first place, the market is not really free. We charge people and companies for dumping garbage but not for pumping hazardous pollution into the atmosphere.

Second, our national security is at stake. How many Persian Gulf wars do we need to fight before we wean ourselves from oil?

Third, renewable energy is new technology, and new technology often needs a boost from Government. In this respect, the United States lags well behind Japan and Europe and the result is becoming increasingly evident. The most recent wind development in California uses Mitsubishi machines. The largest photovoltaic cell manufacturer in the world, Arco Solar, was bought by Siemens in 1989.

I turn now briefly to the National Energy Strategy, which at first reading I must say sounds very good. In the first few pages of reading the National Energy Strategy, you come away with a feeling that the Department of Energy has taken the right course, we are well on our way to making the transition away from fossil fuels. But, unfortunately, the rhetoric supporting renewable energy, at least, is not backed up by strong policies or funding.

I should say up front that UCS supports a number of NES initiatives, such as the streamlining of small hydro licensing, as long as public participation is not restricted; and permanent lifting of capacity restrictions under PURPA.

But key elements of a successful strategy, at least where renewables are concerned, are missing. First, although the NES declares a commitment to accelerating R&D for renewable energy, the actual budget proposal, as we've heard, is only slightly higher than current funding. Even more important than this, Government-industry cost-shared projects, which are essential if new technologies are ever to leave the laboratory, are not given the priority they deserve. On this, I want to say—I'll save that for later. I was going to make a brief aside about Secretary Davis' testimony.

Second, the NES does not propose any mechanism for allowing market prices to reflect the environmental and social benefits of renewable energy or the penalties of fossil fuel use. A production credit of 2 cents a kilowatt hour for renewable electricity supply was cut from the draft NES by the White House. Other price mechanisms, including modest taxes on fossil fuels, should be considered as well.

And, finally, the NES does not commit the U.S. Government to using renewable energy itself. Military bases, for example, could get their hot water from solar arrays. Photovoltaic cells could be placed on the roofs of Federal buildings even here in Washington. Even such seemingly minor steps could give renewable energy industries a critical boost by securing a market for emerging technologies.

To sum up, the NES falls short. We at UCS believe that up to 50 percent of U.S. energy supply could be met by renewables in the year 2030. But neither the specific policies outlined in the NES nor the funding requested will achieve this potential. And I am skeptical that even the modest gains proposed in the NES will actually be met. It is up to the Congress to move Federal policy in the right direction. An especially valuable role for this committee would be to oversee renewable energy R&D programs more closely with the aim of enhancing Government-industry partnerships for commercialization of near-term and mid-term technologies.

Thank you very much.

[The prepared statement of Mr. Brower follows:]

UNION OF
CONCERNED
SCIENTISTS

Renewable Energy:

Prospects, Impacts, and National Policy

Statement by

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To

U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on the Environment

April 4, 1991

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Introduction

Growing interest in environmental problems such as air pollution, oil spills, and global warming have in recent years refocused the nation's attention on renewable energy sources (solar, wind, biomass, hydroelectric, and geothermal[1]). Unfortunately, the debate thus far has been constrained by a lack of information. Most people support the idea of developing environmentally benign, renewable energy sources but believe them to be a long way off. But in fact, even though replacing fossil fuels will be a long and slow process, for the most part, the technologies for exploiting renewable resources are available or close at hand. In this paper I will describe briefly the characteristics of renewable energy sources and opportunities for their development; their potential environmental implications; and the Administration's National Energy Strategy (NES).

Background

Renewable energy sources are often regarded as new or exotic, but in fact they are neither. Until quite recently, in historical terms, the world drew most of its energy from the sun, either directly from sunlight or indirectly through the natural processes that generate winds, rivers, and plants. In the 19th century, the most common source of energy in the United States was firewood. In areas where streams were plentiful, water power was used to thresh grain and mill lumber, and on farms windmills for pumping water were a common sight. Houses were often oriented to capture sunlight in winter and provide shade in summer, and storage tanks were painted black so that water would be heated by sunlight.

Most of these practices were gradually abandoned as fossil fuels--first coal, then oil and natural gas--came into wide use. The two major exceptions are hydroelectric power, which now supplies 10-12 percent of the electricity generated in the United States, and the combustion of wood and wood wastes by homes and industries, which accounts for about 4 percent of primary-energy consumption. In all, renewable energy sources now account for close to 8 percent of U.S. energy consumption, or slightly more than the contribution from nuclear power. (See Figure 1.)

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[1] Geothermal power is a crucial energy source for the future, but because of time and space constraints, it will not be discussed at length here. For more information on this and other resources, see Michael C. Brower, *Cool Energy* (Cambridge: MIT Press, forthcoming).

Interest in renewable energy sources revived in the 1970s out of concern over U.S. dependence on oil imports and pollution caused by fossil-fuel use. Federal funding for renewable-energy research and development (R&D) rose quickly, from $75.1 million in fiscal 1975 to $718.5 million in fiscal 1980. A variety of new technologies were developed and old ones improved, and some attained a measure of commercial success; wind turbines, for example, were installed in large numbers in California in the early 1980s. As the sense of energy crisis faded, however, so did interest in developing energy alternatives. R&D funding dropped precipitously, reaching a low of $114.7 million in fiscal 1989--a cut of almost 90 percent below the 1980 level, if inflation is taken into account. (See Figure 2.)

Yet the advantages of renewable energy sources--particularly wind, solar, and biomass (plant) energy--are, if anything, more compelling today than ever before. The technologies that have been developed, ranging from wind turbines and photovoltaic cells to liquid fuels derived from biomass, are of startling versatility. Most produce little or no pollution and hazardous wastes. Drawing entirely on domestic resources, they are immune to foreign disruptions like the takeover of Kuwaiti oil fields by Iraq, and since their "fuel"--sunlight--is free, they provide a hedge against inflation caused by the depletion of fossil-fuel reserves. Their development would almost certainly result in a net increase in employment, as renewable-energy industries generally require more labor, per unit of energy produced, than coal, oil, and natural-gas industries.

Most important, resources of renewable energy are vast and inexhaustible. Sunlight falling on the U.S. landmass delivers 40,000 quads of energy each year, about 500 times as much energy as the United States consumes. Wind, biomass, and hydroelectric resources, though more modest, are also substantial. In practice, of course, only a fraction of these resources could be exploited because of constraints on available land, the efficiencies of energy conversion, and other factors. Nevertheless, the Union of Concerned Scientists (UCS) estimates that the physically recoverable resources would more than suffice to meet current and foreseeable energy demand. (See below).

Table 1. Estimates of the theoretical and recoverable resources of renewable energy in the United States and their current utilization, in quads per year. Current U.S. consumption of all fuels is approximately 84 quads.

Energy Source	Theoretical Resource	Recoverable Resource	Current Utilization
Solar	40,000	>100	0.06
Wind	3,000	10-40	0.02
Biomass	100	13-26	2.95
Hydroelectric	5.8	3-4	3.07
Geothermal	>1,000,000	>100	0.25

Excluding geothermal, solar energy has by far the greatest potential: solar collectors covering less than 1 percent of U.S. territory--one-tenth the area devoted to agriculture--could make more energy available than the United States consumes in a year. Hydroelectric power has the least room for further expansion, since a large portion of the river resource has already been developed and much of the rest is barred from development by federal environmental legislation.

Renewable-Energy Technologies

Despite the impressive potential of renewable energy sources, they have been virtually ignored by most mainstream energy analysts, who generally regard them as expensive and impractical. Yet the costs of renewable-energy technologies have declined dramatically in the 1980s to the point that some are already competitive with conventional alternatives or are likely to become so before the turn of the century. (See Figures 3 and 4.) Moreover, their reliability has been proven in demonstration projects and actual commercial operation. For some emerging technologies, all that is needed to become fully competitive is a market demand large enough to justify economies of scale. For others, further research and development are required, but their long-term prospects are bright.

Solar

Solar technologies capture sunlight and convert it to usable heat or electricity. They are usually divided into three catagories: solar buildings, solar-thermal collectors, and photovoltaic cells. The solar-building category includes active and passive water heating, space heating, and space cooling. Solar-thermal collectors concentrate sunlight to temperatures (200-3,000°F) that can be used for district heating, industrial processes, and to generate electricity. Photovoltaic systems produce electricity directly through the interaction of sunlight with semiconductor materials.

In the past decade, the costs and performance of solar technologies have fallen dramatically. Close to 300 megawatts (MW) of solar-thermal electric capacity have been installed in the California (entirely with private capital). The most recent installations generate power for about 8-10 cents per kilowatt-hour (c/kWh). With the construction of larger installations (now permitted after revisions to PURPA) the cost is expected to fall to approximately 6-8 c/kWh, roughly competitive with the cost of power produced from equivalent, intermediate-load plants running on natural gas.

Photovoltaic cells are a factor of ten cheaper today than they were a decade ago. The current cost of electricity produced from a utility-scale plant is about 20 c/kWh. As new technologies enter the market, this price could fall to perhaps 6-10 c/kWh by the turn of the century. Even at today's price, photovoltaic cells are in great demand for remote power applications and consumer products--world factory production of cells has increased 20-30 percent per year in the last several years, reaching about 50 MW per year in 1990.

Passive solar designs--which use a buildings structure to capture solar heat in winter or promote cooling in summer--are effective and economically attractive today in new building construction, and design and material improvements will make them more so in coming years. Typically, the cost to construct a solar home is 0-5 percent greater than the cost to construct a conventional home, but energy use is reduced by 40-50 percent, resulting in a net savings to the homeowner. Active solar water heating and space heating--which use solar collectors and, sometimes, pumps to circulate heated fluids through a home--is currently relatively expensive, in part because the market for solar collectors is not large enough to sustain mass production. Even so, solar water heaters are roughly comparable in life-cycle cost to electric water heaters in sunny regions of the country.

Wind

Wind turbines represent one of the best examples of the growing competitiveness and reliability of renewable-energy technologies. Since the late 1970s, approximately 1,500 MW of wind capacity has been installed in the United States (the vast majority in California), while the cost of electricity generated at good sites has declined from over 25 c/kWh in 1981 to about 7 c/kWh today. With additional improvements in efficiency, the cost of wind power is expected to fall to perhaps 4-6 c/kWh within five years. At the current price, wind power is already competitive, or nearly so, with electricity generated by new fossil-fired power plants, and by the mid-1990s it should be one of the least expensive sources of electricity, fossil or renewable. Reliability problems that affected early wind-turbine designs have been largely resolved, and mature and well-maintained systems are available 95-98 percent of the time.

Biomass

Plants are nature's own way of capturing solar energy, and biomass--consisting of wood, plants, and other organic material--is potentially an important source of energy for the United States. The forest products industry (paper, pulp, and wood) already consumes a large amount of wood wastes--about 1.8 quadrillion Btu (quads) in 1990, or about two percent of current U.S. energy consumption--to supply its demand for steam and electricity. And about ten percent of the trash produced by U.S. cities--much of it consisting of paper and yard wastes--is burned for energy.

The most important future application of biomass, however, is in the production of biofuels that could replace natural gas and petroleum for electric utilities, buildings, industry, and transportation. Currently, over 800 million gallons of ethanol--used as an octane-enhancer and lead substitute in gasoline--is being produced from corn surpluses (a comparatively inefficient and costly process supported by government subsidies). In the future, it is conceivable that 30 percent or more of U.S. demand for gasoline could be met by ethanol and methanol produced from trees and shrubs grown on energy plantations. The cost of producing ethanol in this manner has declined fourfold in the past decade--to roughly $1.30-$1.50 per gallon of gasoline-equivalent--and by the turn of the century, ethanol could be cheaper than gasoline on an equivalent-energy basis.

The gasification of biomass is an especially promising approach to producing energy cleanly and cheaply from a variety of feedstocks, including municipal solid wastes. Costs of biogas and syngas (two varieties of fuel) are projected to be well below the cost of natural gas in ten years.

Hydroelectric

The United States is blessed with many rivers and streams capable of supporting hydroelectric power plants. The Federal Energy Regulatory Commission (FERC) has cataloged 7,319 sites in the United States which, if developed, could support 146,900 MW of hydroelectric capacity. Of this potential, about 70,800 MW total capacity have already been developed, and another 1,400 MW capacity are under construction. Thus, in theory, the potential exists for the United States to just about double its present hydroelectric capacity.

However, the resource that could actually be exploited is probably much smaller. Environmental laws, in particular, place severe restrictions on new hydroelectric development. The 1968 National Wild and Scenic Rivers Act and other federal legislation preclude the building of facilities on stretches of virgin rivers representing an estimated 40 percent of the nation's remaining (undeveloped) hydroelectric potential, while an additional 18 percent are under a development moratorium until their final status is decided. Given these constraints, probably no more than half of the remaining potential, or about 37,000 MW, will be available for development.

Many of the remaining opportunities for hydroelectric development involve upgrades or expansions of existing facilities. The capacity of the Grand Coulee dam, for example, was recently increased by over 2,000 MW with the addition of new turbines and the rewinding of existing turbines. In addition, there are over 3,300 small hydroelectric facilities that were abandoned in the 1950s and 1960s, some of which might be returned to operation, as well as thousands of small, nonhydroelectric dams that could potentially be converted to electrical generation.

Energy Storage

What happens when the sun goes down or the wind stops? Conventional wisdom holds that energy storage will be needed to keep the power flowing reliably, substantially raising the costs of solar and wind power. But while the variability of wind and solar power is an important issue, it should not hinder the commercialization of these technologies in the near term. Where the issue of storage is most often raised is in the electric utility sector. But here considerable storage or backup capacity already exists: electric utilities maintain a reserve capacity (typically 20 percent of peak demand) to allow for plant shutdowns and unexpected surges in demand. This reserve should not have to be enlarged until solar and wind energy constitute at least a few percent, and possibly more than 20 percent, of the total electricity supply--a level of market penetration that will not be achieved for at least a decade.

Furthermore, hybrid energy systems drawing on both renewable and fossil sources could provide reliable power while greatly reducing fossil-fuel consumption. The solar-thermal power plants in California, for example, run on 75 percent solar energy and 25 percent natural gas and supply reliable peak power year-round. Natural gas could also supplement solar energy in residential, commercial, and industrial heating applications for little extra cost. By the time solar and wind energy come into wide use, more cost-effective storage technologies--such as underground compressed-air storage and advanced batteries--may be available.

Future Prospects

For all of the progress made by renewable-energy technologies in the past decade, many are still struggling for commercial acceptance. A glut of low-cost fossil fuels, sharp cutbacks in federal support, and above all an energy market obsessed with short-term profits and insensitive to the environmental and social costs--such as pollution and global warming--of conventional energy technologies, have conspired to slow industry growth in the latter half of the 1980s. According to Department of Energy forecasts, renewable energy sources are likely to be providing only about 9.5 percent of projected U.S. energy supply in 2000 and 12 percent in 2010, compared to about 7.5 percent today.

But with appropriate market incentives and strong government leadership (discussed later), this picture could change dramatically. UCS estimates that the share of U.S. energy supply provided by renewable energy sources could be increased to 15 percent--double the present fraction--by 2000, resulting in a 5-10 percent reduction in fossil-fuel use over current projections. UCS further believes that with additional technical progress and policy changes in decades to follow, as much as 50 percent of U.S. energy supply--about 40 quads--could be provided by renewable energy sources by 2030. (See Figure 5.) This projection is roughly comparable to ones contained in a 1990 study called *The Potential for Renewable Energy: An Interlaboratory White Paper*, written by scientists at several national laboratories.

Unlike the White Paper projection, the UCS projection assumes that the United States will make a substantial investment in improving energy efficiency in all sectors of the economy over the next several decades, with the result that overall energy consumption will not grow substantially over today's level. If efficiency does not improve to such a degree, then the renewable share of U.S. energy consumption (in percent) could be lower, but the absolute contribution (in quads) could be higher because there would be a larger market for new energy supply.

It makes little sense to ignore the potential of energy efficiency in making projections of renewable-energy supply, since in most cases investments in efficiency are more cost effective than investments in new supply. Moreover, improving energy efficiency is critical to making the best use of renewable energy sources. For example, biofuels could replace a much larger fraction of U.S. gasoline consumption if automobile fuel-economy standards were raised by 45 percent or more, as

UCS and other groups propose. Similarly, raising standards of insulation in houses will make solar heating more effective and reduce the need for backup fossil or electric heating.

Environmental Implications

All forms of energy supply affect the environment, and renewable energy sources are no exception. When compared to fossil fuels, however, the impacts of renewable energy sources are, for the most part, far less severe and the potential benefits in avoided pollution and global warming great.

Solar

In operation, solar technologies produce no pollution or carbon dioxide (the most important "greenhouse" gas). The main problems associated with them concern their manufacture and disposal. This is especially true in the case of photovoltaic cells. Some types of cells contain highly toxic substances (such as cadmium), while others require the use of toxic substances (such as arsenic) in their manufacture. The dangers associated with these substances can be reduced to a very low level, however, through proper regulation of manufacturing and disposal. Ideally, photovoltaic-cell manufacturers should be required to accept used cells for recycling. (Disposal has not yet become a significant issue because virtually all photovoltaic cells manufactured since the 1970s are still in operation.)

Wind

Wind power is also relatively benign compared to fossil fuels. The main problems associated with wind turbines concern their visual impact in scenic areas, the need to construct roads at some remote sites, noise when located near residential areas, and the killing of birds by rotor blades. Most of these problems can be eliminated through proper siting (though siting constraints reduce the size of the accessible wind resource). One of the best options is to site wind turbines on farms and pastureland. (The largest wind facility in California, at Altamont Pass, uses farmland--at considerable profit to local farmers.)

Biomass

More serious environmental issues are raised in the case of biomass. Burning any sort of biomass produces air pollution (such as particulates and nitrogen oxides), and if not properly controlled, emissions can be as bad as or worse than those from fossil-fuel burning. The mass incineration of municipal solid wastes is of particular concern, since such wastes often contain toxic metals and other compounds that can pose a major health risk. Technologies are available that greatly reduce most types of pollutant emissions, but in some cases--especially municipal solid wastes--they may not be enough to satisfy public concerns.

Fuels derived from biomass, on the other hand, are much cleaner. Biogas and syngas burn as cleanly as natural gas, and gasification may be the best approach (besides recycling) to extracting energy from municipal solid wastes. As EPA studies have shown, ethanol and methanol are far less polluting than gasoline, although to achieve the maximum pollution benefits, car engine designs must be carefully optimized for these fuels.

The growing of energy crops on a large scale--the only option if biomass is to contribute a large share of U.S. energy supply--could have substantial impacts on land quality and use, but interestingly, it is not clear whether the overall impacts would be positive or negative. Much depends on the types of land placed under cultivation and methods used. Contrary to popular belief, energy crops would not generally displace food crops or cause food prices to rise. Most energy crops would be planted on marginal cropland not now in use as well as pastureland and existing forestland. Because most energy crops would be grown in cycles of several years before being harvested, their planting would actually reduce soil erosion and enhance water retention on stressed land. Yet, intensive cultivation of short-rotation trees and shrubs could have substantial negative impacts, as well, if fertilizers, pesticides, and herbicides were used excessively.

Burning biomass produces carbon dioxide, but if the biomass consists of waste that would burn or rot anyway, or if it is continually replaced by new growth of energy crops, then there would be no net contribution to global warming.

Hydroelectric

The impacts of hydroelectric power depend strongly on the type of facility and its location. In general, damming a river is very damaging to ecosystems both upstream and downstream. Upstream of the dam, large tracts of land are flooded, destroying the natural habitat. (Indeed, hydroelectric reservoirs damage or destroy a greater land area per kilowatt-hour produced than any other energy resource, fossil or renewable.) Downstream, river flows are greatly reduced and the quality of the water--mineral and silt content, for example--radically changed. For these reasons, UCS is skeptical that further large-scale hydroelectric development is desirable in the United States or, indeed, the rest of the world. In developing countries, in particular, a number of very large and costly projects are under way which promise to wreak tremendous damage on regional ecosystems and indigenous peoples.

Small-scale hydroelectric projects, especially those that do not dam a river but only divert part of its flow to power production, are much less damaging. Each such project, however, must be evaluated on a site-specific basis to determine its acceptability.

Implications for Global Warming

Could energy efficiency and renewable energy sources play a major part in helping to slow and eventually stop global warming? Most likely, yes. If nations took full advantage of opportunities to improve energy efficiency, global fossil-fuel use and carbon-dioxide emissions would grow relatively slowly. And if, in addition, renewable energy sources were developed to their full potential, fossil-fuel use and carbon-dioxide emissions could be cut well below today's levels.

This was the conclusion, for example, of a 1989 Environmental Protection Agency study that examined a wide array of policy options for mitigating global warming. Under the EPA's rapidly-changing-world (RCW) scenario, policies designed to promote energy efficiency and renewable energy sources were judged able to reduce the earth's warming commitment (temperature increase to which the earth will be committed) an estimated 27 percent by 2050 and 42 percent by 2100. Energy efficiency and renewable energy sources were about equally important in this analysis and together accounted for nearly two-thirds of the total warming reduction--65 percent--deemed feasible in the next century. In contrast, nuclear power's potential contribution was judged to be less than one-third that of either energy efficiency or renewable energy sources alone. (Among other policies considered were changes in agricultural practices and reductions in the use of chlorofluorocarbons.)

The National Energy Strategy

The Department of Energy's proposed National Energy Strategy (NES) clearly recognizes that renewable energy sources could play a valuable part in reducing environmental damage from fossil fuels. For example, in the NES Renewable Energy Excursion (described in a supporting document), it is projected that renewable energy *could* supply 36.6 quads in 2030, roughly double the base case projection of 18.2 quads. However, neither the specific policies outlined in the NES, nor the funding requested, will permit renewable energy sources to attain anywhere near their likely potential, and UCS is skeptical that even the modest gains proposed in the NES will actually be achieved. (See Figure 6.)

We support a number of NES policy initiatives, such as the streamlining of small-hydroelectric licensing procedures (as long as public participation is maintained) and removal of restrictions on the size of small-power producers using renewable energy sources under PURPA.

But several key elements are lacking from the NES. First, although the NES declares a commitment to increasing R&D for renewable energy, the actual budget proposal for FY 1992 is only 2.6 percent higher than current funding ($164.1 million as opposed to $159.8 million). Even more importantly, the Department of Energy does not propose funding a significant number of government-industry cost-shared demonstration projects, which could be essential to bringing emerging technologies to the marketplace. Thus, it appears that the United States will continue its historical pattern of investing only a very small portion of energy R&D funding in renewable energy sources. (See Figure 7.) For its part, UCS proposes increasing renewable-energy R&D funding by 20-30 percent per year for the next several years, until funding approaches $1 billion in today's dollars (approximately the 1980 level).

Second, the NES does not propose any mechanism for allowing market prices to reflect the environmental and social benefits of renewable energy sources (or the penalties of fossil fuels). A number of possible mechanisms are conceivable. For instance, PURPA could be revised to require environmental and social "externalities" to be taken into account when public utilities contract for new electricity supply. Massachusetts, New York, Wisconsin, Nevada, and other states are already considering or have adopted such policies, yet federal regulation could ensure that they are applied across the country. This could give renewable energy sources a critical edge in competitive bidding for power contracts.

Tax credits could be offered to encourage investments in renewable energy sources. At the moment, only a 10 percent credit is available for solar, ocean-thermal, and geothermal business investments. Tax credits for wind, biomass, and residential energy investments--the last a key prop supporting the residential solar-collector industry--were eliminated in 1985. UCS proposes that these tax credits be restored and, if possible, enlarged. To avoid some of the problems associated with earlier credits, the new credits should be tied to performance and energy output, rather than to installed capacity; in addition, the federal government could certify renewable-energy systems to ensure that they meet strict standards of reliability and performance.

Taxes on fossil fuels (beyond those already levied by federal and state government) would also encourage the development of renewable energy sources by sending a clear price signal to consumers. For example, an additional gasoline tax of 30 cents per gallon, phased in over several years, would make ethanol and methanol relatively much more attractive and would accelerate their introduction into the marketplace. Energy taxes could also be a valuable source of funding for research on alternative energy sources. And from a free-market standpoint, they would help the economy run more efficiently by making consumers more aware of the external costs--such as the health impacts of pollution or the security costs of protecting Persian Gulf oil supplies--associated with fossil fuels.

Finally, the NES does not say that the U.S. government should become a major purchaser of renewable-energy technologies for buildings, military bases, transportation fleets, and other applications. Government buys could help create a sizable demand for new technologies that otherwise would have difficulty penetrating the market. For instance, large solar-collector arrays--such as those already installed on some prisons, hospitals, and other institutions--could provide hot water for military bases. Photovoltaic cells could be installed on the roofs of federal buildings to help offset peak electricity demand. And fleet vehicles, such as postal trucks, could be adapted to using ethanol and methanol (as well as electricity or compressed natural gas). On a life-cycle basis, many such investments might be cost effective today, particularly when their environmental and social benefits are taken into account.

Conclusion

In sum, the NES was a good effort, but fell far short of what is necessary to move the United States away from overreliance on fossil fuels. The proposed policies, though useful in some respects, are narrowly drawn and, hence, of limited value. Moreover, the Administration appears unwilling to commit resources needed to implement even these policies effectively. Alas, it is up to the Congress to correct the deficiencies in federal policy.

FIGURE 1

US Energy Supply —1989

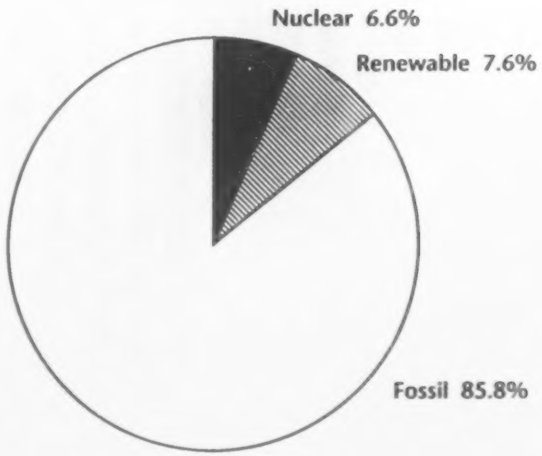

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FIGURE 2

Federal R&D Funding for Renewable Energy

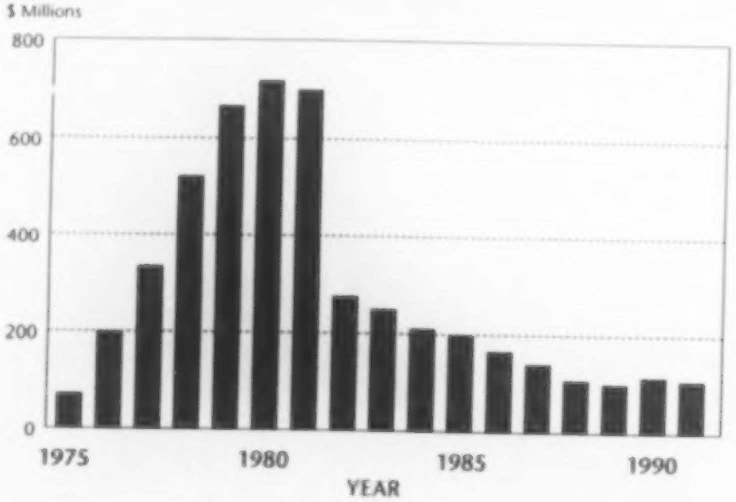

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FIGURE 3

Cost of Electricity

(Levelized 1990 Cents/kWh)

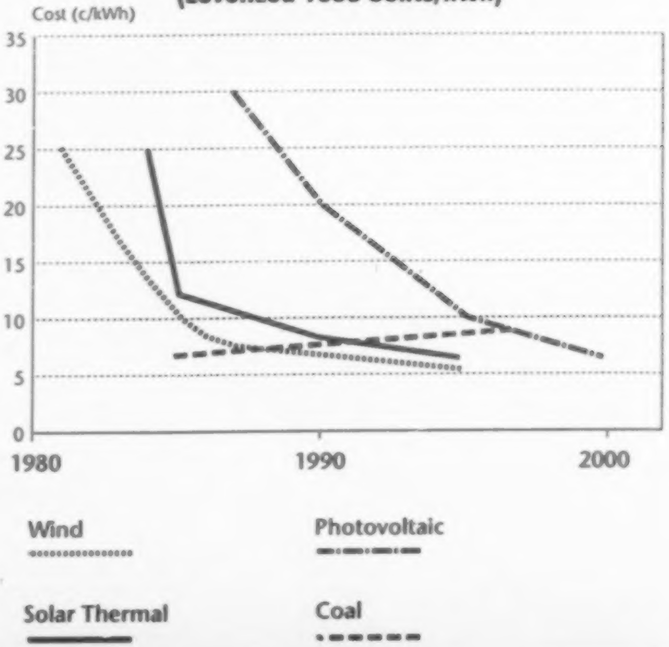

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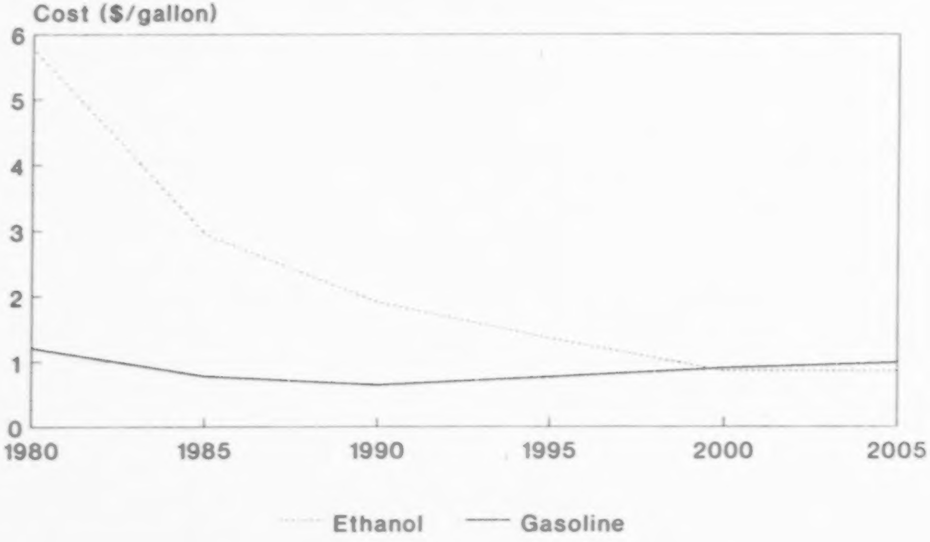
FIGURE

Costs of Gasoline and Ethanol

(1990 Dollars/Gallon•)



•Production costs only, expressed in gallons equivalent of gasoline.

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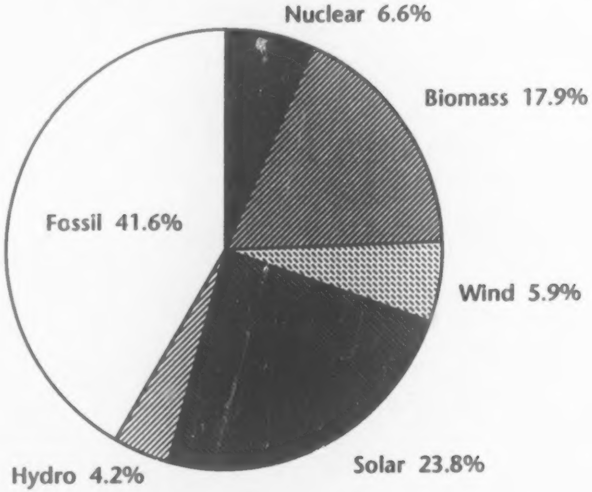
FIGURE 5

US Energy Supply —2030
(High Renewables Scenario)*



*Assumes energy efficiency improvements hold overall energy use to 1990 levels.

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FIGURE 6

Renewable Energy Projections

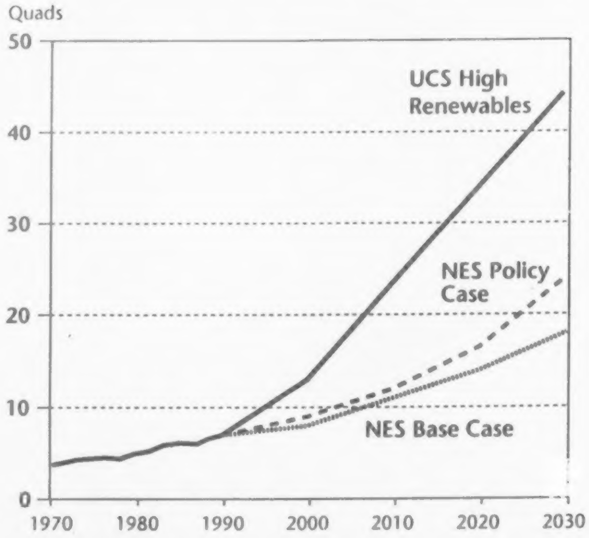

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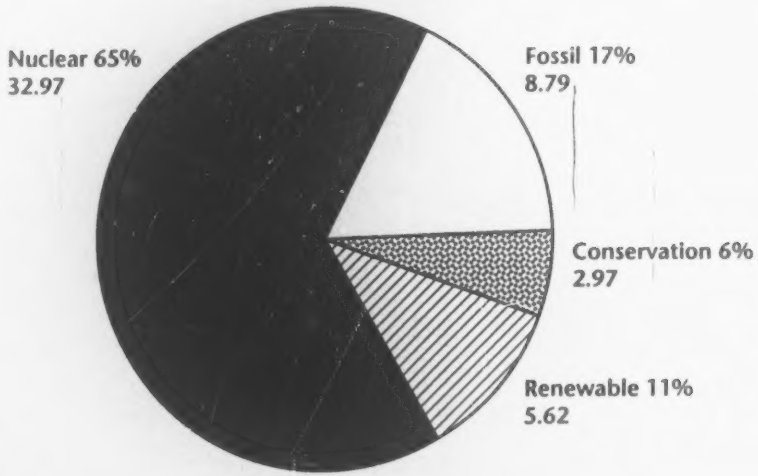
FIGURE 7

Energy R&D Spending, FY48-FY90

($ billions, 1982 constant)



Source: DOE

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MICHAEL BROWER

Michael Brower is a physicist and analyst for the Union of Concerned Scientists in Cambridge, Massachusetts. In his three years at UCS he has published numerous articles on nuclear arms policy, most recently "In Search of the Elusive Stealth Bomber" in the May/June 1989 issue of *Technology Review* and "Targeting Mobile Missiles: Prospects and Implications" in the September/October 1989 issue of *Survival*. His analysis of the missions and capabilities of the B-2 Stealth Bomber have helped shape the debate over the future of that program.

Dr. Brower also specializes in energy policy and is the author of a recent UCS report entitled *Cool Energy: The Renewable Solution to Global Warming*. He received his Bachelors of Science at the Massachusetts Institute of Technology in 1981 and his doctorate in physics at Harvard University in 1986.

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Mr. SCHEUER. Thank you very much.

Mr. Jonathan Becker.

STATEMENT OF JONATHAN BECKER, ENERGY POLICY ANALYST, PUBLIC CITIZEN, WASHINGTON, DC

Mr. BECKER. Thank you, Mr. Chairman, and members of the committee. My name is Jonathan Becker. I am an energy policy analyst with Public Citizen, a non-profit consumer and advocacy organization representing 100,000 members nation-wide. I would like to thank the subcommittee for holding hearings on the urgent need to increase funding for the research and development of renewable energy technologies.

I am also here today as a representative of 32 organizations that have endorsed this document, "Recommendations for the U.S. Department of Energy's Research and Development Budget for Renewable Energy Technologies for Fiscal Years 1992-1994," which is our alternative to the Bush Administration's proposal. We recommend that the DOE spend $462 million on wind, solar, hydroelectric, geothermal, biomass, and hydrogen energy technologies in fiscal year 1992, and to increase that level to $652 million in fiscal year 1994.

Our alternative budget gives justifications and recommended funding levels down to the line item level, and includes a description of the cost, present contribution, and near-term potential of each renewable energy technology. Overall, our recommendation represents a three-fold increase over President Bush's proposal, but, as the Chairman noted, it is still only a fraction of what was spent on these technologies during the Carter Administration.

The 32 organizations that worked on and endorsed the alternative budget include environmental, consumer, religious, and trade organizations, as well as the associations representing State energy officials, and municipal utilities. It is a broad coalition but it was brought together by one common belief—the Administration's budget for the research and development of renewable energy technologies was completely inadequate.

Despite minimal Federal support during the past decade, renewable energy technologies today provide fully 10 percent of domestic energy production. Fifty percent of that comes from biomass and wood, and forty-five percent comes from hydropower. The remainder is made up by solar thermal, photovoltaics, solar building technologies, wind, and geothermal.

As earlier speakers have noted, prices for these technologies have fallen dramatically. Since 1980, photovoltaic prices, for example, have dropped almost 85 percent, and wind prices similarly have dropped approximately 75 percent. In many cases, the renewable energy technologies are cost competitive with or cheaper than conventional sources such as nuclear power, fossil fuels. And you add in there environmental benefits, they are an even greater bargain.

The 10 percent of domestic energy production provided by renewable energy technologies is more than is provided by the Nation's nuclear power plants and so-called clean coal facilities combined. It is clearly more than is being supplied by nuclear fusion, which may never generate a single watt of electricity. It is a mystery us, therefore, that the White House wants to spend at least two times as much on nuclear fission, nuclear fusion, and clean coal each than it plans to spend on all the renewable energy technologies combined. In fact, for every dollar the White House proposes to spend on energy R&D, less than 6 cents would go to renewables.

The United State's failure to support the renewable energy technologies has created a great opportunity being seized by our international competitors. Germany, Italy, and Japan, among others, each out spend the U.S. on photovoltaic, wind, and other renewable energy development. For the United States, this means a loss of jobs and a widening trade deficit as the Nation is forced to import renewable energy technologies.

Renewable energy is here today. The 10 percent of domestic energy production now supplied by renewables proves that. That the contribution will grow is also certain. But how much of the DOE funds renewable energy R&D will determine where we draw the line against environmental harm from fossil fuels and nuclear power. It will also determine whether American companies can compete in the international marketplace and bring jobs and trade home to the United States.

This alternative budget is our recommended blueprint on how R&D can help protect the environment, build a strong domestic renewable energy industry, and create jobs at home. Detailed down to the line item level, it gives reasoned and justified recommendations on what to spend and how to spend it. We urge Congress to take it into consideration in funding substantial increases in renewable energy R&D.

Thank you.

[The prepared statement of Mr. Becker follows:]

PUBLIC CITIZEN

Buyers Up ☐ Congress Watch ☐ Critical Mass ☐ Health Research Group ☐ Litigation Group

Written Statement of

Jonathan Becker
Energy Policy Analyst
Critical Mass Energy Project
of Public Citizen

Subcommittee on Environment
House Committee on Science, Space, and Technology

April 9, 1991

215 Pennsylvania Ave. SE ☐ Washington, DC 20003 ☐ (202) 546-4996

Public Citizen is a non-profit consumer and environmental organization founded in 1971, with approximately 100,000 members nationwide. The Critical Mass Energy Project is the energy policy arm of Public Citizen. Public Citizen coordinated work on Recommendations for the U.S. Department of Energy's Research and Development Budget for Renewable Energy Technologies FY 1992-1994, which was endorsed by the following organizations:

Alliance to Close Indian Point
American Solar Energy Society
American Public Power Association
American Wind Energy Association
California Energy Company
Citizen Action
Consumer Federation of America
Context Institute
Earth Energy Association
Environmental Defense Fund
Environmental and Energy Study Institute
Geothermal Resources Council
Greenhouse Crisis Foundation
Maine Audubon Society
Massachusetts Citizens for Safe Energy
National Association of State Energy Officials
National Hydropower Association
National Wood Energy Association
Northeast Sustainable Energy Association
Nuclear Energy Information Service
Nuclear Information and Resource Service
Passive Solar Industries Council
Public Citizen
Renew America
SAFER-2
Save Our World
Solar Energy Industries Association
Union of Concerned Scientists
The United Methodist Church, General Board of Church and Society
U.S. Public Interest Research Group
Westchester Environmental Coalition
20/20 Vision National Project

Our proposal calls for the U.S. Department Energy to spend $462 million on wind, solar, hydroelectric, geothermal, biomass and hydrogen energy technologies in fiscal year 1992, and to increase that level to $652 million in fiscal year 1994.

The specific recommendations for each technology are as follows (all figures in millions of dollars):

	DOE	DOE	Alternative Recommendation		
	FY91	FY92	FY92	FY93	FY94
Joint Initiatives	$17.85	17.5	150.0	200.0	250.0
Biomass	$28.18	32.4	56.0	64.5	68.5
Geothermal	$26.02	18.39	42.7	41.7	36.7
Hydrogen	$1.94	2.6	6.6	8.9	11.7
Hydropower	$0.99	1.04	4.55	7.05	1.85
Photovoltaics	$45.52	49.3	80.5	91.6	101.8
Solar Buildings	$1.97	1.0	6.5	7.15	7.85
Solar Thermal	$19.11	19.57	55.5	71.4	83.3
Wind	$10.9	13.7	27.0	43.25	56.75
Associated Line Items	$7.66	16.03	32.7	36.35	34.05
TOTAL	$160.14	171.53	462.05	571.9	652.5

Overall this represents a three-fold increase over the $164.1 million President Bush proposes, and yet it is still only a fraction of what was spent on these technologies during the Carter Administration. In addition, President Bush has offered no proposed funding levels past the next fiscal year.

This alternative budget is the product of almost four months' discussion and consultation among environmental, public policy, and consumer organizations, as well as industry trade associations and government officials.

Our budget includes an examination of each renewable energy technology's current energy contribution, cost, and near-term potential. This is followed by a detailed break-down of the proposed funding for each technology and, within each technology, a justification for every single line item expenditure.

Our recommendations include significantly enhanced funding levels for each renewable energy technology plus a series of new initiatives to promote the expanded use of renewable energy technologies.

A cornerstone of our proposal is to fund, at $150 million in FY92, a series of joint government-industry ventures. These joint ventures mean that the government, in 50-50 partnership with industry, would aggressively develop technologies that have been proven in the laboratory but which have not yet been demonstrated on a large commercial scale.

Every single federal budget through the Reagan and Bush Administrations until last year cut funding for renewable energy technologies. After eight straight years of cuts, funding for renewables had been reduced to about 10% of the peak FY79 level.

This alternative budget is the second edition of a budget we released last year. At that time members of the coalition worked closely with Congress, and for the first time in nearly a decade funding for renewable energy research was increased, not decreased. This year we look forward to further cooperation.

Our budget this year includes a detailed narrative on reasons why we must make up lost ground in renewable energy research and development and ultimately go even further to promote renewable energy technologies.

Key among these reasons is that the Administration's budget proposal will fail to expand rapidly the use of renewable energy. In that respect, the President's budget is a clear reversal of an earlier promise.

In his State of the Union address, President Bush called for "increased development and greater use of alternative fuels." Yet the renewable energy budget he is proposing actually represents a cut in funding below last year's level for these technologies.

Energy Secretary James Watkins acknowledged that during the nearly two years of public hearings to prepare the National Energy Strategy citizens made it clear again and again that energy conservation and renewable energy had to be the cornerstones of any future energy plan. Yet when finalizing the budget, the White House slashed the DOE's request for renewables by 26%. That is nearly double the average reduction the Office of Management and Budget made in all other energy technology budgets.

Despite very little federal support during the past decade, renewable energy technologies have made great strides. And this progress, despite an imbalanced energy market strongly tilted in favor of fossil fuels and nuclear power, indicates the strong additional promise for renewables.

Right now renewable energy technologies provide fully 10% of domestic energy production. Fifty percent of that comes from biomass, 45% from hydropower. The remainder is made up by solar thermal, photovoltaics, solar building technologies, wind, and geothermal. The costs for these technologies have fallen dramatically in the past decade. Since 1980 photovoltaic prices, for example, have dropped almost 85%, and wind prices, similarly, have fallen approximately 75%. In many cases renewable energy technologies are cheaper than conventional sources such as fossil fuels or nuclear; when their environmental benefits are included, they are an even greater bargain.

The 10% of domestic energy production that renewable energy resources provide is more than is produced by all the nation's nuclear power plants and so-called "clean coal" facilities -- combined. That 10% is clearly more than is being produced by nuclear fusion, which may never generate a single watt of electricity.

It is a sign of misplaced priorities that the White House wants to spend at least two times as much money on nuclear fission, nuclear fusion, and clean coal each than it plans to spend on all the renewable energy technologies combined.

In fact, for every dollar the White House proposes to spend on energy R&D, less than six cents would go to renewables.

Although we have just ended a costly war with Iraq, the Bush Administration has apparently not learned the lesson that the U.S. must wean itself from its addiction to oil. In fact, the President is proposing to spend less money on renewable energy technologies during all of 1992 than the U.S. currently spends for oil imports in a single day.

Another compelling reason to increase substantially our investment in renewable energy is that other countries are taking dominant positions in world renewable energy markets, and the United States is being left behind. Germany, Italy, and Japan, among others, each outspend the U.S. on photovoltaic, wind, and other renewable energy development. For the United States, this will mean a loss of jobs and a widening trade deficit as the nation is forced to import renewable energy technologies.

As an example of Europe aggressively promoting renewable energy technologies, seven European countries now outspend the U.S. on wind energy development. The effect: in just four years during the 1980s, while the government was cutting back support for wind, the U.S.'s share of the world market dropped from 27% to 5%. The U.S. is also being outspent thirty times over by the European Community for renewable energy export promotion.

Failure to make significant increases in funding for renewable energy research and development would be quintessentially, and tragically, penny-wise and pound-foolish.

A recent white paper by the Department of Energy's laboratories found that even with minimal government support renewables could contribute an amount of energy equal to half this country's present energy consumption by 2030. Waiting that long, however, will mean that there will be an even greater distance to make up with our international competitors and that the environment will suffer continued harm that is both preventable and expensive to remedy. Dramatic increases in research and development funding are essential now to speed the development of renewables; this country simply cannot afford to wait forty years.

That the contribution of renewable energy technologies will grow is beyond doubt. But to insure that this development happens sooner rather than later - that we buy renewable energy technologies from American and not foreign companies, that we minimize environmental damage from fossil fuels and nuclear power, that we reduce energy costs and increase energy security - we urge the U.S. Congress to give strong support to renewable energy research and development.

Mr. **Scheuer**. Thank you very much.

Congressman Dick Swett.

Mr. **Swett**. Thank you. I feel like we're preaching to the choir. I want to talk about a couple of things that I didn't get a chance to talk about with the previous witness. The first is to emphasize or to explore the ways to motivate a quicker development of this renewable energy resource. Number one, the regional approach to me seems to be a way that could be utilized very effectively. In particular, I look at this country and see that the southwest holds the greatest potential for solar development, the southeast for natural gas development, the northeast for biomass and waste energy development, and the northwest in hydro and biomass. My question is do you see any way that this approach would be able to garner the attention of and foster quicker development of these individual technologies as applied regionally within the country. I will address that question to Mr. Brower first.

Mr. **Brower**. I think that a regional approach is absolutely essential to the development of renewable energy sources. I think that most resources are very region specific, as you pointed out. Furthermore, there are vested interests in each region which would benefit from the development of renewable energy sources. In the midwest, certainly the development of energy crops——

Mr. **Swett**. Sure. I overlooked that.

Mr. **Brower**. And in the northeast, improved utilization of forest resources and so forth. Off the hand, I cannot think of specific policy recommendations on the regional scale. I would be happy to do some more research on that and communicate with you on that later.

Mr. **Swett**. Okay. My other comment that I would like to hear your thoughts on, Mr. Becker, has to do with the storage potential. One of the things that has come to my attention as I worked in the energy field myself is that this country has probably a 2 percent storage capacity as compared to the European and Japanese storage capacity of nearly 20 percent. My understanding has been that as we have moved more toward a service oriented society, we have made less efficient the use of our generating stations because we do not have the kind of loads in the off-peak hours that we once had because industry is no longer operating on a 24 hour cycle.

To me, there is a tremendous need for the storage capacity. I am curious—obviously hydropower and batteries are two technologies that seem to be discussed a great deal, but I have had access to and have been able to observe the use of compressed air energy storage, for instance. My feeling is that there ought to be more emphasis placed on this storage capacity, not only that it relates to a technology that I am familiar with, but, more importantly, it has a tremendous impact on the efficiency and, therefore, once again we get around to the more efficient our production of energy is in this country, the less impact on the environment we ultimately realize, and I think the more cost-effective that production is.

Could you give me a comment on that, please?

Mr. **Becker**. I don't want to preach to the converted again, but I would——

Mr. **Swett**. Well, we're all doing that.

Mr. **Becker**. I would agree with you completely. We have great potential to increase the use of renewable energy resources in this country. But one barrier to that is they are not always where we want them to be and when we want them to be. You mentioned pumped hydro storage before. That's a promising technology that is already being used. I haven't heard hydrogen talked about in great detail today but that's another very promising technology. There has bee research done in the prospect of building large solar energy farms to create hydrogen that could be pumped or transported across the country.

So in terms of getting the most out of our renewable energy resources, the issues of storage and transportation of those are very important and are addressed in our budget as well. We recommend increase in funding for hydrogen research and there are also promising avenues to be explored in fuel cells and pumped hydro and so forth.

Mr. **Swett**. Is the observation that I have had through my professional experience consistent with your findings, Mr. Brower, that we essentially only have a 2 percent capacity to store energy and that our society is moving more to a daytime peak demand society and, therefore, reducing the efficiency of our power plants?

Mr. **Brower**. I think that has been the trend in the last decade or so. I think the more innovative electric utilities are considering strategies for reversing that trend. I would look at, for example, Pacific Gas and Electric's moves to reduce peak loads through the use of photovoltaic cells at the end use side near communities as they grow. And this is going to be very important for the future of utilities because one of the big constraints is not overall generating capacity but the peak capacity and ability to transmit and distribute that electricity. And it is very expensive to increase the capacity of transmission lines and often it is quite difficult because of opposition from local residents.

So, in that case, storage and solar energy can work in tandem to help level out peak loads and use our resources more efficiently. I think that's true.

Mr. **Swett**. What role in this research has EPRI played in providing funds for research and data for different groups looking into these problems?

Mr. **Brower**. In general, in the area of renewable energy sources, EPRI is rather backward. But in the area of storage, they are much stronger, mainly because utilities are interested in storage whether or not the resource is renewable or non-renewable.

Mr. **Swett**. My impression has been that they are probably an industry leader when it relates to storage.

Mr. **Brower**. That's right. I think so. There are several demonstration projects—utility scale batteries, compressed air storage, and so forth—in which EPRI is closely involved. I think that is very beneficial.

Mr. **Swett**. Are any of these in operation yet, or are they still under construction or in the development phase? I am familiar with the Birmingham, Alabama compressed air energy storage project which hasn't yet been completed. But are there other areas that have been shown to work effectively?

Mr. **Brower**. Compressed air prototypes have been completed and there are some prototype advanced utility scale batteries that have been completed and are running. I think that in this area it is really just a matter of time before they are introduced. Compressed air storage to me is perhaps the most attractive in many circumstances because where it is feasible you can make use of depleted natural gas wells and there is very little or no environmental impact.

I have a particular problem with pumped storage because——

Mr. **Swett**. So have I.

Mr. **Brower**. Yes. Because in expanding pump storage capacity you often do need to flood areas, just like you do to build large hydroelectric facilities, and that is not something we generally support. It depends on the specific circumstances.

So compressed air storage—advanced batteries have some environmental problems as well that need to be addressed through careful regulation. They often use components that are very toxic and so they have to be recycled. Once those issues are settled, I think there is great promise for those technologies.

Mr. **Swett**. Well, I appreciate your coming and testifying before this committee. I wish the room was full, that we had TV cameras running constantly. This is an issue that I think needs the attention of the public and at this point in time I feel that we are not getting the attention that we if not deserve, we ought to command because of the situation that this country has just come through.

I thank you again, and defer back to the Chair.

There is no Chair. [Laughter.]

Well, why don't we continue on then. We will operate according to schedule and we will invite the third panel to come.

Thank you once again, Mr. Brower and Mr. Becker.

We are now going to hear from Mr. Scott Sklar, Mr. John Perry, Mr. Donald Klass, Mr. Randall Swisher, and Mr. Kent Burton. It appears that the remainder of the crowd will serve as the final panelists.

You gentlemen must realize that as a freshman congressman whose professional background is in energy, this is a grand opportunity which I relish with great enthusiasm. So I am not at all dismayed that we are here alone in this room together. We will find plenty of things to talk about.

Mr. **Sklar**. Are you ready to commit the subcommittee to certain actions now that the Chairman is gone?

Mr. **Swett**. Well, had I realized I would be in this position, I think I should have gone around and collected proxies and maybe I would have been ready. But at this point in time, I haven't been given the authority. So, with all honesty and regret, I will just defer and listen to your testimony, then hopefully engage in enlightening conversation.

I believe that we will start with the testimony of Mr. Scott Sklar, the executive director from Solar Energy Industries Association here in Washington, DC.

I defer back to Mr. Chair.

STATEMENT OF SCOTT SKLAR, EXECUTIVE DIRECTOR, SOLAR ENERGY INDUSTRIES ASSOCIATION, WASHINGTON, DC

Mr. SKLAR. Thank you, Congressman Swett.

The Solar Energy Industries Association is the national trade organization of both the photovoltaics and solar thermal manufacturers. The reason we're coming to you to ask to increase Federal research and become a more aggressive Federal program is basically three reasons: (a) It creates jobs, (b) it provides energy security, and during the Iraqi war it was amazing how many calls came into our office from the State of Hawaii that got delays in their shipments of oil and the industry was asking for industrial process heat either from solar or, in this case, even biomass; and (c) that it is clean energy. The fact that we have a renewable energy allowance reserve in the Clean Air Act and our first funding out of EPA shows that the fact is that renewable energy can be an environmental mitigation technology as well as an energy technology and that it may be far more cost-effective to have clean energy up-front, in the beginning, than clean it up at the end.

We ask you to authorize funding at far greater levels than we ever had before. In fact, not that we're being greedy, but the fact that we are mature and now you can realize 10 years of investment potential. The Solar Industries Association is asking for $143 million, up from $68 in three areas—photovoltaics, solar thermal power, and solar buildings. Of that $60 million increase, essentially half of that—or all of that, is cost-shared 50–50 with industry. So you are really getting $120 million of research out of it.

We are also asking for $26 million out of the renewable programs for what I call auxiliary programs. "Corect," the interagency board that promotes exports. Technology transfer, which has been slaughtered and, as the Chairman so noted, is ridiculous to cut when you need to transfer out of the lab to the private sector——

Mr. SCHEUER. Cut by 75 percent.

Mr. SKLAR. Seventy-five percent. And energy storage, which these technologies absolutely need to be more cost-effective, and resource assessment, so that both domestically and internationally we can tell our end-users what these can do.

The benefits out of these technologies or the highlights of the research is pretty simple. In photovoltaics, the solar electric cells, we have a new manufacturing initiative and the whole idea is how to scale up existing manufacturing plants to overcome certain technological hurdles to lower systems cost. What you have before you is a plastic panel. It is thin film photovoltaic technology. It is the lowest production cost there is. You may have seen on Dan Rather this week that Texas Instruments and Southern California Edison have a new technology; an absolutely brilliant idea in terms of using tiny, minuscule spheres which basically enhance the sunlight to make it more efficient at very low cost. And, thirdly, the concentrated technology that just has been shown on the 3M research facility in Texas that uses Fernel lenses and concentrators to increase efficiency. What you have out of photovoltaics is a crash program to get this down in the 1990s for peak power in the United States.

On solar thermal technology, you also have a crash program. We have nearly 400 megawatts of solar troughs in California, 8 cents per kilowatt hour electricity. If you support what we ask for, we will get that cost down to 6 cents per kilowatt hour in two years, 50–50 cost share.

We also have works with three industry teams to take dish engine technology, which can also produce 8 cents per kilowatt technology, and get that up using teams with Detroit Diesel, Cummins, and Westinghouse so that we can provide 8 cents per kilowatt modular technology all over the United States.

And, finally, solar building technology. Thirty-five percent of our energy goes for energy in the building sector. Solar water heaters, 1.2 million buildings in the United States have Solar water heating and it is cost-effective from Maine to Arizona. And the fact is the Administration request for $1 million, down from $5 million two years ago, down from $72 million eight years ago, is a tragedy. We already off-set 1,366 megawatts, or about a nuclear power plant and a third, and we can quadruple that in ten years with some new technology and joint ventures.

Lastly, joint ventures. What we have is a new concept that was passed in Public Law 101–218, and that is it gives the DOE program the right to commercialize technology and cost-shares with industry. OMB allowed DOE a paultry couple of million to get in the joint venture game. I have just been appointed by Secretary Watkins on the Joint Venture Advisory Committee to DOE that will guide this. There at least needs to be $8 million minimal for renewable energy joint venture cost-shares to get this technology validated in the field. We also need work with DOE and this subcommittee to start amortizing this technology over longer time periods. Congressman Swett brought up the idea that why can't the farm sector use it. Because we can't access rural REA loans, 35 year, 2 percent interest loans, that diesel generators can but photovoltaic and wind can't. We can't access Farmers' Home Administration loans with solar water heating, industrial process heat but coal and oil process heat can. And the program needs to help us with this.

Finally, the authorization levels—I'm pretty close—authorization levels are lower in many cases than appropriation levels. We need the subcommittee to act this year to solve this problem or we will be really hurt in the process.

What I believe we have for you is a series of technologies that our competitors are investing in more than we are. If you want this technology to be U.S. by the year 2000 rather than importing it, you need to up the ante.

And my last little demo for you is this is what we worked with DOE on, a solar photovoltaic directory for exports. You can see the cover. To show you that copycats the Japanese, the new Energy Foundation used almost the same graphic artist for their own industry a year later. They have built and really expanded international markets. They are spending more than we are because they want to produce this technology. We have an opportunity and we need your help.

Thank you.

[The prepared statement of Mr. Sklar follows:]

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TESTIMONY

by

SCOTT SKLAR
EXECUTIVE DIRECTOR
SOLAR ENERGY INDUSTRIES ASSOCIATION

before

HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
SUBCOMMITTEE ON ENVIRONMENT

APRIL 9, 1991
WASHINGTON, D.C.

INTRODUCTION

The Solar Energy Industries Association (SEIA), the national trade organization of the photovoltaics and solar thermal manufacturers and component suppliers, requests an enhanced U.S. Department of Energy solar research and development effort for FY'92. With nearly 500,000 troops still situated in the volatile Middle East and over 55 percent of U.S. energy imported, it is imperative that the solar option be realized.

Today, SEIA asks the House Science, Space & Technology Subcommittee to increase authorization limits beyond the existing appropriations levels. If the Congress fails to do this, the future of the solar research program will be severely limited. The industry's FY'92 funding recommendations are asking for a much higher increase than in past years, inasmuch as it is critical to finally commercialize much of the technologies in the 1990's. With increased concerns about imports, energy security, international competitiveness, and global climate change, the 1990's is the decade of opportunity. The SEIA recommendation includes funding for cost-shared joint ventures between industry, endusers, and the state and federal governments as authorized under P.L. 101-218. These recommendations are:

International (CORECT)	$2.5 million
Photovoltaics	$82.5 million
Solar Buildings	$5.5 million
Solar Thermal	$55.5 million

If the United States is to take advantage of our technical lead in solar technologies and the ultimate jobs, profits, and energy savings derived from our leadership, we must take advantage immediately of our competitive edge. Since our international competitors are outspending our government's R&D funding, we run the risk of being undercut and ultimately importing the very technologies in which we now lead. Such a loss of technical and competitive leadership would be a tragedy.

In this testimony, I have outlined the contributions of the federal solar research programs, the recommended projects for the upcoming year, and a status report on the solar industry -- all which should lay the foundation for an enhanced federal solar program which is supported by the National Energy Strategy.

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PROGRAM CONTRIBUTIONS IN FY'91

International: The International line item has supported the activities of the federal interagency board established to promote renewable energy exports, The Committee on Renewable Energy, Commerce and Trade (CORECT). Since over 55 percent of U.S. solar and renewable energy equipment and services are exported, it was essential to coordinate our government activities so that the U.S. industry would not lose world market share to subsidized financing and tied aid programs of our competitors. In FY'91, CORECT supported renewable energy industry project identification teams in The Phillipines and Indonesia, a market study of solar thermal opportunities in North Africa, and a new project to identify successful approaches and encourage U.S. industry to provide sustainable products and services for village power systems. An effort to streamline and simultaneously access financing from the four U.S. export agencies is underway.

Photovoltaics: The highlight of the photovoltaics program is the Photovoltaics Manufacturers Inititiative which solicited plans from 66 U.S. companies for cost-shared assistance to help existing manufacturers overcome certain technological hurdles to scale-up manufacturing. This program, if funded consistantly by Congress over the next three years, will result in a 20 percent decrease in prices which will make photovoltaics viable in the utility peak power markets rather than just the remote markets beyond the utility grid. Other successes involving the completion of a megawatt of scaled-up photovoltaics at Pacific Gas & Electric and a third-of-a-megawatt of concentrating photovoltaics at the new 3M Research Center in Texas, is moving the technology into the mainstream of utility use.

Solar Buildings: This program funded at the million level in FY'91 has assisted industry in developing system certification tests which will allow the HUD/FHA loan program to allow the technology under the HUD Minimum Property Standards as a way to incorporate solar systems into the mortgage. Generic testing was carried out to predict performance as a way to insure customers and utilities of the energy savings, The program also supported solar cooling research which was successfully carried out by the Florida Solar Energy Center.

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Solar Thermal: The solar thermal electric program has been revived to carry out three separate commercialization activities in FY'91. First, the program has entered into a cost-shared development program to develop a third generation solar trough which would allow solar thermal electric applications to drop to 7 cents per kilowatt hour. Second, analysis on the potential to upgrade the Solar One Central Receiver to validate the component development work funded by DOE over the last few years was carried out. Third, RFP's went out to solicit complete working systems of dish/engine technology which matches new dish concentrator with stationary stirling engines mounted at their focal point. This particular testing project represents the first step to commercialization. The solar thermal industrial part of the program has two distinct activities of note. First, a new solar detoxification initiative has set up a prototype solar detoxifyer at Lawrence Livermore and conducted an RFP for industry to provide mobile solar detoxification prototypes. Second, a new solar industrial process heat effort is underway to assist industry in opening markets to provide water heating and steam for the industrial sectors overly reliant on imported oil.

SERI Building: Congress appropriated money in FY'91 for SERI to build a new laboratory facility and they have a preliminary design which incorporates passive solar design features. Industry has maintained that cost-effective applications of solar water heating and photovoltaics should be incorporated in the building because their not doing so would send the wrong market signals to the building and financing communities (If the premier solar laboratory doesn't use these technologies, why should anyone else?).

Energy Storage

In FY'91, $900,000 was directed towards cost-shared development of a new solar battery/control device for easier integration of solar and renewable energy applications with the utility sector. The program is essential to insure that the technology developed through DOE's support can eventually be used by the intended enduser. This project represents the first time the Energy Storage program was focussed on the solar and renewable energy industries actual market needs.

REQUESTS FOR FY'92

International: Because of management reorganizations in DOE, CORECT has lost some focus. Obviously, industry believes that any market promotion program should be industry-driven. This means that $2.5 million for FY'92 should have a strong market focus by assisting industry to establish in-country training for potential purchasors, to establish generic overseas promotion offices to maintain a high-profile, consistant overseas presence in the Eastern Europe, Pacific Rim and Caribbean Basin markets. Finally, CORECT should continue the work in streamlining export assistance from federal agencies and support interagency pre-investment assistance through the newly-created International Fund for Renewable Energy & Efficiency (IFREE).

Photovoltaics: An increase in the photovoltaics program is essential, and industry's request for $82.5 million will allow the second phase of the cost-shared Photovoltaics Manufacturing Initiative to begin. Beyond this initiative and the $45 million core research program, the remaining $22 million is divided into three areas of critical research. Nearly half this money should be directed to accelerate photovoltaics in the utility sector by continuing PV/USA to validate technology scale-ups and provide some funds for joint ventures with other utilities throughout the United States. A special focus is needed on various concentrator technologies as a way to bring the 36 percent efficiency breakthrough from the laboratory into the marketplace. And and new $4 million effort on thin films applied research in which industry can speed the development of more efficient thin-films to the building and utility sectors. The industry believes the core research work at the Solar Energy Research Institute and the systems design work at Sandia National Laboratories must continue as a balanced program with equal weight.

Solar Buildings: This program must be broadened beyond the pure research and testing activities. In FY'92, the solar buildings activities must assist industry in cost-shared development of new glazings, valves, and related system innovations. Therefore the bulk of the $5.5 million must go towards industry-directed projects to build collector efficiency. A special components initiative with the existing industry must be started in 1991 and a report to Congress on its progress should be required.

Support of applied research at the Florida Solar Energy Center particulary in the area of active solar cooling and solar component assistance is essential to the success of the program. Finally, a new effort to build an industry market through DOE's Weatherization Program must be supported by this program to insure installer certification and training of solar water heating equipment. Nearly 20 percent of total energy in buildings use goes towards water heating.

Solar Thermal: The program has been oriented towards the industrial and utility sectors and SEIA recommends $55.5 million in FY'92. In the electric program, a high priority must be given to validating at Solar One the new heliostat and molten salt receiver technologies in a joint venture with industry, the State of California, and the utility (Southern California Edison) for a $7 million contribution for the first year. An additional priority must be assured to validate under a cost-shared joint venture both utility and remote dish/stirling solar systems with three existing industry development teams for a total of $11 million. An additional $2 million must be made available to continue the new generation of solar troughs for the elctric sector. The industrial programs must also be continued with $2 million going towards a feasbility program for solar industrial process heat and preheat in cooperation with state governments, and a solar detoxification program of at least $8 million for actual prototype validation with real endusers who need their wastes remediated.

MISCELLANEOUS PROGRAMS

Several programs for FY'92 must be expanded to prepare the industry for rapid commercialization and market penetration in the 1990's:

Energy Storage: Approximately $8 million in FY'92 should be set-aside for solar battery storage programs and balance of systems validation. Of this, $4 million should be relegated for hydrogen production as an energy storage approach for solar and renewable energy technology applications. Emphasis on unique concepts as well as practical approaches to lower control, interconnection and storage costs must begin now. Work should continue to be cost-shared with the big-three automakers on a new photovoltaics battery development project. The Energy Storage program must be made more relevant to the breadth of the solar industry.

Joint Ventures: Under P.L. 101-218, DOE was directed to established federal government-supported joint ventures, where the federal contribution is 50-percent. In Fy'92, SEIA supports $8 million of additional joint ventures which leverages utility, industry, state & local government funds to buy down the risk of new solar technologies and applications. Such cost-sharing is the only way the conservative building, financial, and utility sectors will accept solar and renewable energy applications at a larger level. Risk-sharing is the only tactic to aggresively build markets.

Resource Assessment: A minimum of $5 million is requested to begin an ambitious resource mapping project. First, country-by-country resource maps are needed by industry to access markets in Eastern Europe, the Pacific Rim and the Caribbean Basin. Likewise, industry needs state-by-state resource maps for state public utility commissions and other regulatory bodies to be the basis for consideration in regional and micro -applications. Lack of refined resource data is a market barrier that now must be corrected at a time when our markets are expanding.

SERI Laboratory: The industry supports continued funding of the laboratory only if cost-effective solar water heating and solar electric (photovoltaics) systems are included in the building. By SERI being unable to accomodate these applications, negative market signals would be sent which would undermine U.S. industry in the building and financial markets.

Technology Transfer: Industry supports the improving Solar Technology Information Program and commend DOE and the national laboratories for the materials they developed and supported. However, an additional $3 million must be directed to establish new approaches to transfer information from the federal laboratories to industry. The laboratories should be solicited for innovative concepts in cooperation with the national trade associations, and awards should be made on merit.

These programs deserve greater attention by the Subcommittee to insure relevance to the core and applied federal solar research and development programs.

CONCLUSION

The United States is being outspent by the federal research and development programs of our international competitors. While the U.S. still leads technologically, we must leverage the pure research in the 1980's into real world applications in the 1990's. Certain tactics need to be applied to insure success.

First, the core research programs must be maintained. We have done so for nuclear fusion, allegedly for long term benefits, and thus we should do so for solar and renewable energy for the same reason.

Second, we must add incrementally to applied research with an emphasis on greater industry cooperation. Such an approach requires more innovative technology transfer approaches from the laboratories to industry.

Third, we must use research and develoment initiatives to draw industry players into proactive projects and into strategic areas of development. Use of such initiatives to validate applications in the real world are critical. Such initiatives are the only way corporate boards are willing to make commitments.

Fourth, joint ventures which are cost-shared by a range of partners are the most effective way to leverage few federal dollars into larger investment dollars. New technologies require innovative ways to enter market readiness. Joint ventures share the risk and allow industry and endusers to build their learning curve.

Fifth, market development is required through education, resource assessment, and aggressive market promotion and export assistance. Only through this stage will the market be prepared to accept new technologies and applications.

With the advent of the Clean Air Act, The Gulf War, and technological breakthroughs, solar energy has the greatest chance for real market penetration in the decade of the 1990's. We hope that the U.S. Congress will seize the moment and join our industry and the American public for a solar future. Thank you.

ADDENDUM

Factsheet #1

Utility-Scale Solar Thermal Electric Generating Facilities

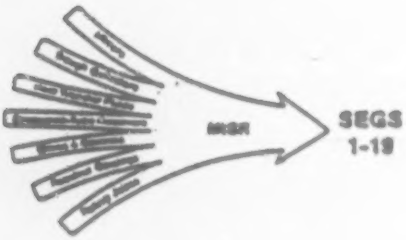
Present Status. Over 350 megawatts of utility-scale solar thermal electric generating capacity is now on line and integrated into the U.S. electric utility grid. The largest units in service today are 80 megawatts, which will expand in over 100 megawatt increments now that the PURPA cap has been temporarily waived. Future growth of the solar thermal electric generation industry is dependent, in large measure, on the continuance of federal support.

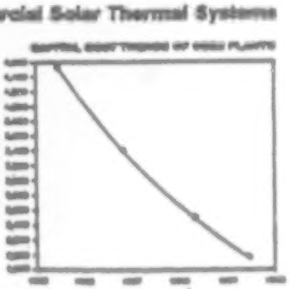
Importance of Federal Research. Lower costs will enhance the industry's ability to attract private capital. It is difficult to raise capital for relatively low fossil fuel prices over the past decade; it has been a challenge for the solar thermal industry to remain competitive in a marketplace where prices are based on fossil fuel costs. Since 1984 the lifecycle cost of producing solar thermal electricity has been reduced from 24 cents per kilowatt hour to 8 cents per kilowatt hour -- a 67 percent improvement in five years.

At the present time, the solar trough R&D program has the potential to provide the margin of economic viability through technology improvements to reduce generating costs to approximately 6 cents per kilowatt hour. Industry funded research and development is presently underway to accomplish the necessary technology improvements, but will take two years to reach fruition. Central receiver and dish/engine applications also have the potential to meet these low costs at even higher efficiencies.

Particularly at a time when Congress and the Administration are struggling to fashion policies to encourage the development of clean sources of power as quickly as possible, this proven mechanism should be retained to keep private capital flowing into solar projects which have already demonstrated reliability.

Environmental Benefits. Each 80 megawatt solar facility is capable of reducing the cost of oil imports by $280 million over the thirty year life of a project. While it is difficult to quantify the economic value of energy independence and fuel diversification, it is becoming increasingly clear that the economic value of reducing pollution outweighs the cost of R&D. The economic value of the emissions reductions is more than twice that amount, without placing any fixed value of carbon dioxide emission reductions.





Factsheet #2

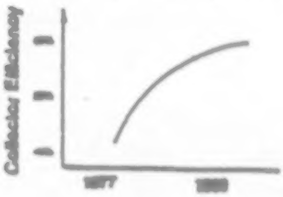
Commercial-Scale Solar Water Heating and Industrial Process Heat Applications

Present Status. Approximately 1.5 million buildings in the United States use solar thermal applications to heat water, create steam for industrial processes, or heat space which displaces 1.366 megawatts (equivalent) of electricity. Solar water heating makes up nearly 90 percent of the market and about 15 percent of the current installations are in the commercial sector. Future growth of commercial applications of solar thermal technology involve ways to lower up-front costs in a technology whose payback runs from 5 to 10 years. The building sector uses 35 percent of energy for lighting, heating & cooling & process heat.

Importance of Federal Research. Our industry faces a market impediment regarding solar technologies which have inherently higher up-front capitalization but whose life-cycle costs are less than conventional thermal energy applications when fuel costs are taken into account. As a result of technology improvements, increased market penetration, and a stronger delivery infrastructure for maintenance, solar thermal applications have increased dramatically in recent years in the commercial sector. Efficiency has increased from 40 percent in 1975 to over 60 percent in 1990 with maintenance problems dropping to less than 3 percent nationwide. Industry/DOE R&D programs are underway and need continuance to assist in the integration of certified solar equipment in the existing Federal Home Administration (FHA) loan program. Once that is achieved, solar thermal will be more easily integrated into federal loan programs which finance commercial installations such as the Farmers Home Administration (FmHA) financing program which is likely within the next five years.

Environmental Benefits. Solar thermal applications can offset nearly 25 percent of U.S. energy use. Emissions from the building sector account for nearly 25 percent of environmentally-degrading emissions through either direct combustion of fossil fuels within the building structure or by utility plants providing electricity to these structures. The economic value of reducing pollution clearly outweighs the costs of federal R&D. The building sector is the least expensive way to curtail emissions other than car-pooling.

Efficiency Has Improved



Factsheet 93

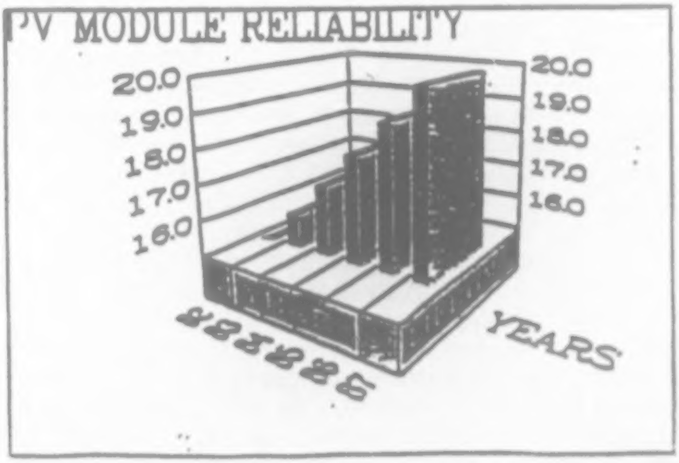
Photovoltaics for Utility and Commercial-Scale Applications

Present. Nearly 35 megawatts of photovoltaic (solar electric cells) electricity is interconnected with our nation's utilities and utilized by the commercial sector. Most utility companies are using photovoltaics for off-grid applications such as powering communications, sign & area lighting, and for buildings. While sales for photovoltaics have increased nearly 35 percent from 1989 to 1990, the sales increase was predominantly for the Third World.

Importance of Federal Research. While solar photovoltaics have reduced their costs ten-fold in the last decade, currently photovoltaics are three-fold higher than baseload conventional energy. Environmental benefits, modularity, and ease of use combined with fast plant construction times and natural compatibility with peak power needs make photovoltaics far more attractive than its higher cost would belie. The U.S. photovoltaics industry is in the classic chicken-and-egg situation, that with enhanced cost-shared R&D, industry will be able to scale-up their manufacturing facilities which could cut costs by 30 percent.

The Administration has proposed a Photovoltaic Manufacturing Initiative in both its FY'91 and FY'92 budgets. The U.S. Department of Energy establish this program to assist the U.S. photovoltaics industry to scale-up its production to meet an increased world market threat by our international competitors.

Environmental Benefits. Photovoltaics directly convert sunlight to electricity without noise, moving parts, or emissions. The maintenance of photovoltaic equipment is minimal and thus environmentally benign. The United States must be prepared to create an environment for private sector investment in photovoltaics or the U.S. will lose its lead, only to import the technology at the beginning of the 21st century from our international competitors.



Mr. SCHEUER. I take it you mean they want to produce the technology for export to us, inter alia.

Mr. SKLAR. Absolutely.

Mr. SCHEUER. They look upon our country as an export market for this kind of thing.

Mr. SKLAR. Absolutely. And what is so frustrating in this is that we lead the technology. They are not doing anything sleazy. The fact is they see an opportunity. We have got to kick the Government and force our industry to cost-share, I'm for that, but we have got to kick some action here or we are going to loose this opportunity even with the best intentions.

Mr. SCHEUER. Thank you.

Mr. John Perry.

STATEMENT OF JOHN H. PERRY, JR., CHAIRMAN AND FOUNDER, ENERGY PARTNERS, WEST PALM BEACH, FL, ACCOMPANIED BY JERRY JONES, PRESIDENT, ENERGY PARTNERS

Mr. PERRY. Thank you, Mr. Chairman. First of all, thank you for allowing me to address you and the committee members on topics that are extremely important to me as a businessman and as a human being. My name is John Perry and I am the chairman of Energy Partners. Behind me is Jerry Jones, who is Energy Partners president.

Over the past 25 years, I have been actively involved in numerous renewable energy technologies, spanning the spectrum that includes photovoltaics, windmills, hydroelectric, hydrogen generation, methanol reformation, and fuel cells. While many of my other businesses have been very profitable, it is fair to say that I have yet to see the first dime of profitability come from our activities in renewable energy. It must be a labor of love because nothing else yields a satisfactory explanation.

We are frankly pleased to see increased fiscal year 1992 budget requests in the conservation and renewable area. While we see $142 million has been requested for solar energy, only $2.6 million is targeted for hydrogen research. We also see that only $9.5 million has been requested in the transportation budget for fuel cell vehicles, and all of these dedicated to the existing fuel cell bus program and a General Motors contract. There is little, if any, funding requested for the small, innovative companies that have traditionally taken the risks that lead to meaningful rewards for the country. We wish this was not the case, as we believe innovation in renewable energy systems containing fuel cells is going to be crucial to our country's future role in the world marketplace.

If you think we are zeroing in rapidly on fuel cell technology, you are correct. Energy Partners is a company that was founded for one purpose—that of finding a meaningful way to make significant progress in the application of renewable energy. When we did the economic and technical research that was the base for the planning for the company we found there were two critical points of knowledge that evolved. First, was that in our long-term energy future there will be eventually two major energy currencies—hydrogen and electricity. Secondly, we found that all evidence lead to the fact that fuel cells will be the silicon chip of the future. We, or no one else, has a clear picture on how these points will evolve but we are convinced they are correct.

We then determined that our strategic role should be that of a facilitator or catalyst to apply the various individual renewable technologies into demonstrable systems. We formed technical alliances or partnerships with leading manufacturers, universities, and organizations to ensure that our input base of technology would continue to be current on an on-going basis. We were not, are not, and will not be a commercial threat to these individual companies, as we are clearly supportive marketers and appliers of their technologies.

We also found that our appetite for profits would continue to have to be satisfied elsewhere, as the profits arising from successful applications are probably ten years away. While the Japanese have a long-term mentality for profitability, U.S. companies substantially have not. We decided that if we were to encourage others to invest in a renewable energy future whose profit window is long-term, we would have to encourage the active financial participation of our Government. We would have to encourage the Government to develop tax incentives that are both meaningful to the industrial investors as well as useful to the public. That is why we are pleased to be here today supporting efforts we believe to be honorable.

We believe a strategy needs to be adopted that will encourage and speed the application of zero emissions fuel cell based engines in our transportation sector now. We believe you must lead the way by encouraging shared investment between Government and industry. If a Canadian Province like British Columbia, whose population is less than half of New York City, can set aside $100 million for hydrogen development and $500 million spent daily on Desert Storm, a meaningful budget allocation to move us from a polluting energy source to a non-polluting solution should be attainable.

We have requested in the fiscal year 1992 budget support for the initiation of the Green Car program that demonstrates fuel cell technology applied to a car. The project requires about $3.3 million to reach demonstration in about 13 months. We are proposing to fund $1.5 million ourselves and are asking $1.8 million in participation from the Government. We believe this is the type of project that is essential to our energy future.

Systems demonstration projects, particularly in an area as key as transportation, will uncover supporting subsystem technology weaknesses and force further technological development. Successful demonstration and application will spur on the development of supporting infrastructure, such as fueling, that naturally develop to support new working systems. Manufacturers will be encouraged to build in meaningful numbers if they see markets appearing as a result of successful system demonstration. It is the right way to proceed.

Thank you for allowing us the opportunity to share these thoughts with you. We encourage you to join us in taking an active leadership role in this important work.

[The prepared statement of Mr. Perry follows:]

RENEWABLE FUELS
and
FUEL CELL VEHICLES

Testimony Before the

Subcommittee on Environment
Committee on Science, Space, and Technology

U. S. House of Representatives

April 9, 1991

Presented By:

John H. Perry, Jr.
Chairman

and

Jerry J. Jones
President
Energy Partners
West Palm Beach, Florida

Biographical Outline
John H. Perry, Jr.

Mr. Perry is a native of Seattle, Washington. He graduated from Hotchkiss in 1935, Yale in 1939, and attended the Harvard School of Business Administration. During World War II he served as a pilot in both the Anti-Submarine Service and the Air Transport Command.

Mr. Perry is presently the Chairman of Energy Partners, Inc., a company dedicated to the application of clean, renewable energy systems. He serves as Chairman of the Perry Group, Perry Oceanographics, Hydrogen Systems, N.V., and is the Chairman of several non-profit corporations.

Prior to 1969, Mr. Perry was Chairman, President and principal shareholder of Perry Publications, Inc. which operated 28 newspapers, as well as magazine publishing and printing operations. He is widely recognized for his pioneering introduction of computers for automated newspaper production in the composing room. This was a forerunner to today's techniques in high-speed newspaper production.

Mr. Perry is equally recognized for his numerous contributions to the underwater world, both commercially and for the U. S. Government. He built the underwater astronaut/scientist training facility off the Bahamas, known as "Hydro-Lab". The Hydro-Lab was known for many underwater "firsts", including the dry transfer of men from a submarine (also Perry-built). He was on President Johnson's U. S. Commission on Marine Sciences, Engineering and Resources.

Since 1969, Mr. Perry has devoted time and significant financial resources to the development of renewable energy technologies and a global energy strategy. He established research facilities in South Florida and on his private island in the Bahamas, testing photovoltaics, windmills and fuel cells. He has patented a system for making methanol from seawater and launched the first commercial submarine powered exclusively by a fuel cell power system.

Mr. Perry has had a long a distinguished career with a common thread always present,....he has consistently dedicated his resources and efforts towards activities and projects that have value on a human scale as well as a business scale.

Mr. Chairman and Members of the Subcommittee, my name is John H. Perry, Jr., and I am the founder and Chairman of Energy Partners. With me to today is Mr. Jerry Jones, who is the President of Energy Partners. We are pleased to be here to share with you our thoughts on the renewable energy portions of the FY 1992 Budget, and to offer our appraisal of business opportunities existing within the technologies that make up the renewable energy sector. We will also try to provide some tangible examples of how we believe government and industry can work together to accelerate the evolution to an energy future that offers greatly reduced environmental pollutants.

I have personally provided funding and been involved for over 25 years in developing and testing energy components and systems based on clean, renewable, energy sources. This has encompassed technologies as diverse as windmills, photovoltaics, fuel cells and hydrogen-powered internal combustion engines. In the late 1960's my companies built and powered the original underwater Hydrolab (for Astronaut training) with hydrogen-fed fuel cells. In the 1970's and 1980's we built manned submersibles powered by several types of fuel cell systems, including what we believe was the first use of the Proton Exchange Membrane or PEM cells in 1989. We built electrolytic conversion systems that converted seawater into hydrogen-rich methanol. We call this our SEAFUEL process, which is patented. All of these technologies were developed within the Perry Companies that were the forerunners of Energy Partners.

Energy Partners is a company committed to the practical demonstration and application of renewable energy systems technology. We have elected to take this course of action because we felt someone in the private sector needed to be encouraging the development and providing a market for the many sub-technologies that make up a complete renewable energy system. As the name "Partners" implies, the Company has entered into strategic written relationships with manufacturers, universities and organizations that have technologies that are applicable to such systems.

We feel this approach will also allow a close cooperation between industry and government through mutually agreeable joint industry and government demonstration platforms, which will increase the public awareness of what can be done with the existing state of renewable energy systems. This is particularly directed toward the area of fuel cell power systems applied to the transportation sector. The seriousness of our conviction is evidenced by our proposed cost share program in FY 92, whereby we are proposing to provide $1.5

million of our funds, in combination with a requested $1.8 million in government funds, to build the fuel cell/battery powered, zero emission vehicle, ***Green Car,*** that provides an important stepping stone in the long term solution for our nation's transportation system.

For this first cooperative effort, Energy Partners has teamed with Consulier, a U. S. Department of Transportation approved Original Equipment Manufacturer (OEM) of automobile bodies and other equipment. The Consulier car has a unique space-age advanced composite primary structure, which is very light in weight, while maintaining the necessary strength for durability and safety. Consulier has the excellent combination of automotive expertise while being small enough to change directions and take the risks which innovators must take. For technical assistance in addition to its own in-house capability, Energy Partners intends to work closely with both Georgetown University and Argonne Laboratories. While the first phase of the project is to deliver a zero emissions proof-of-concept car in about 13 months, the entire ***Green Car*** program is structured in six phases that will result in the production of such automobiles in meaningful quantities.

Mr. Chairman, we are encouraged by the budget request for the Conservation and Renewables program that has been submitted for FY 92. It is certainly a step in the right direction compared to what we have seen over the past ten years; however, it is lacking in the area of hydrogen utilization. We see solar energy up to $142.9 million (as compared to $129.4 million in FY91), yet only $2.6 million is targeted in FY 92 for Hydrogen Research, Development and Demonstration (RD&D). This would appear to us who are active in developing this technology as very short-sighted. Similarly, in the Transportation Budget, there is only $9.5 million for fuel cell vehicles, and at present these funds are allocated to a fuel cell bus program and a General Motors Contract. There is little, if any, money for the small, innovative, risk-taking kinds of projects that the smaller companies of our country have routinely done. These are the kinds of projects that lead to the formation of economic forces in the marketplace, like the Polaroids and Xerox's of today's economy.

In the area of Fuel Cell vehicles, we personally know of at least four viable University and Industrial entities which can do an excellent job of integrating state-of-the-art fuel cell systems into transportation vehicles. The zero pollution and high efficiencies of these systems should give them substantially higher priorities than we see in this budget. This would lead us to believe that a Fuel Cell Vehicle budget closer to $20 million is warranted. This would then allow DOE to be responsive to Title VIII, Sec. 807 of the Clean Air Act Revisions. We also would like to point out the Hydrogen Development Act now in draft form in the U. S. Senate, and recommend that this act be included in this Committee's Authorization Bill.

In the area of hydrogen research, per se, we feel that the $2.6 million requested is not responsive to either PL 101-566, the Spark Matsunaga Hydrogen Research and Development Act, or to the level of importance that Hydrogen RD&D should have in the U. S. This is graphically evidenced by the recent Canadian initiatives, whereby the British Colombia provencial government, alone, announced its intention to fund $100 million (Canadian) for Hydrogen RD&D. The province of British Columbia has a population of about 3 million, or roughly half that of New York City. The United States needs a level of effort that is at least significant enough to allow us participation with Canada in an effort that could be so vital to all of us in the future. We in the U. S. will not reap benefits without meaningful participation. We must take a leadership position.

One area that also seems to us to be lacking in the implementation of renewables is tax incentives. We are aware, of course, of the general R&D Tax Credit and of the Solar and Renewable credits which have such a fight getting renewed from year-to-year. However, Mr. Chairman, history has shown us that a sound, dedicated approach using tax incentives enabled the development of the strong, powerful gas and oil industry that we have in the United States today. We believe that the Energy Tax Act of 1978 needs to be revisited, especially in the areas of Business Energy Tax Credits. Tax credits for business investments in technologies which use or produce alternative forms of energy will create the incentive for numerous partnerships, such as ours, to substantially participate in the furtherance of our national goals in renewable energy through meaningful inputs of private sector funds. We would like to see inital credits in the 50-70% range to create the needed "jump start" of such partnerships. Considering the $500 million per day cost of Desert Storm, this is a small and sound investment.

Virtually all opportunites in the private sector regarding development and application of renewable, non-environmentally-damaging energy systems require a long term investment strategy and mentality. This is because the financial returns on such investments will probably not begin to yield favorable results for upwards of 10 years. There are an increasing number of us in the business community, however, that believe that this investment in dollars and technology must be made now for the security and well-being of the future generations of both the United States and the planet Earth. This is in spite of the lack of short-term financial objectives. It is honorable work that needs undertaking.

Most, if not all of us here, know that we as a nation use almost a third of the fossil-based fuels harvested worldwide. We also know that we are paying a price far beyond that reflected in our utility bills or posted at the local gas station for the use of these fuels, both in our industrial and private lives. The final price is reflected across a broad spectrum of our economy and partially includes items such as health costs, political aid packages, military expenditures, environmental clean-up costs, and the results of increased global warming. Of course, as we try to mitigate the results of our addictive use of fossil fuels, we also spend an additional billion dollars annually in research to try to find ways to reduce the negative effects derived from their use.

Given this scenario, it is not merely desireable that industry and government find meaningful and fruitful ways to cooperate in the development and application of renewable, environmentally-friendly energy systems; it is mandatory. Private industry must be "incentivized" to look beyond short term profitability in the U.S. or we will find ourselves once again behind in an industry dominated by the Japanese and the Europeans. Japan in particular has historically supported, and is presently supporting the increased development, and even more importantly, application, of renewable energy technologies within their country.

Before we can look at recommendations as to how the government can support U. S. industry in a meaningful and constructive manner that will be of benefit to all U. S. citizens, we must first address the need for a unified, directed strategy. We believe the correct strategy is to support steady, meaningful, and measureable progress through active and joint support of demonstrations of the best renewable energy systems. This strategy will uncover subsystem weaknesses, and will force technological breakthroughs in areas that have the potential for such breakthroughs. I submit that fuel-cell power systems for use in the transportation sector of our economy is, and should be, at the heart of this strategy.

The buzz words commonly heard in renewable energy today relate to our need to make the transition from fossil fuels to a "Hydrogen Age" or "Hydrogen-based Economy." We need to progress toward such a future, but we are not going to get to a fully integrated hydrogen economy in any reasonably predictable timetable. The data needed to give us a window into how and when that future will occur is unknown. We *are* going to get there, but the many hydrogen support infrastructures needed that are not existing today, will have to be developed and built, with at least the level of safety we have with fossil fuels today. The only things we can reasonably predict from our economic and engineering models done today are two basic "givens" for the deep future....*hydrogen and electricity will be the energy currencies of the future, and the fuel cell will be the "silicon chip" of that future.* Hydrogen and electricity will be "currencies" because they are complimentary. Each can be used to make the other, but better storage alternatives exist with hydrogen.

The fuel cell will be the "silicon chip" because there is not a single, present energy system application, either utility or transportation, that could not be performed by a fuel cell fueled by either hydrogen or a hydrogen-rich fuel. While the basic fuel cell uses hydrogen and oxygen as energy feedstocks to make useable direct current electricity, its byproduct is water; not carbon monoxide, carbon dioxide or nitrous oxide, but drinkable water. This water can be used again to produce hydrogen through electrolytic conversion. We firmly believe that the future holds great economic rewards to the country that leads in the development and application of fuel cells and their related technologies.

While we presently use hydrogen to power our spacecraft rockets, and as a feedstock for fuel cells onboard those spacecraft to power many systems (including life-support systems), the technology to build such systems is not presently economic. It has only been in the last several years that a newer class of proton exchange membrane (PEM) fuel cells have been developed. This is important because the cells have the potential to gain widespread use (particularly in transportation applications) due to their size, efficiency and power-handling abilities. They also have the potential to be cost competitive with fossil-fuel burning engines if they were manufactured in meaningful quantities to a receptive marketplace. We personally have applied such fuel cells in manned underwater submarines. They are presently being applied in a limited number of other programs by ourselves and others, mostly through government cost sharing programs. These systems sometimes solve previously unsolveable range, space, or heat problems, making them fall in the category of "enabling technology". There is another technology presently being researched in solid oxide fuel cells (SOFC). Sizes and power densities of the SOFC cells are even more promising than the PEM technology, and these cells are more forgiving of the quality of the feedstock fuel.

By developing and successfully demonstrating fuel cell technology in the transportation sector, the market needed to stimulate the fueling and support infrastructures will naturally follow. At the appropriate time, again within the overall strategy objectives, similar shared funding programs can be targeted at specific support technologies that are needed but have not kept pace with the transportation "vehicle' development.

The governmental and industry departments and organizations to make a joint industry-government program work are already in place. The Secretary of Energy and the Hydrogen Technical Advisory Panel (established under Section 108 of PL #101-566) already have the people with the dedication to make meaningful progress. Broad industry support for this approach has been indicated through the National Hydrogen Association. The only lacking ingredient is budget committment on a meaningful scale.

I urge the subcommittee to take a leadership role and support this industry/governmental initiative and other initiatives that support the strategic objectives outlined herein. Thank you for your attention.

Mr. SCHEUER. Well, thank you for your magnificent sense of timing. [Laughter.]

Thank you for your stimulating testimony. It was foolish of me not to mention your remarkable record of accomplishment. Unfortunately, we have five stars here today and I can't do justice to any of you. But you have carved out a truly remarkable career and I congratulate you. We look forward to working with you, indeed, all of you since you are representatives of industry, to carve out new paths of cooperation both with the Congress and the Executive Branch, universities. We have got to have a consortium of talents between the universities, the great research labs in this country, both in universities and in private business, and the Executive Branch, and the Legislative Branch; and we have got to come up with problems, sharing the challenge and joining the genius. I look forward to working with all of you.

Okay. Dr. Donald Klass, president of the Biomass Energy Research Association, Washington, DC.

STATEMENT OF DR. DONALD L. KLASS, PRESIDENT, BIOMASS ENERGY RESEARCH ASSOCIATION, WASHINGTON, DC

Dr. KLASS. Thank you, Mr. Chairman, and members of the subcommittee. Because of the time limitation on this presentation, I won't review the first few pages of our statement which we submit for the record. But I would like to urge you to spend a few moments reviewing the first three pages of our statement when you have the opportunity because I tried to point out how biofuels can play an important role in our national energy strategy and in meeting the requirements of the Clean Air Act Amendments of 1990.

We have reviewed DOE's proposed fiscal year 1992 biofuels research budget, and are pleased with the detail on the allocation of funds to specific research areas. In their request, DOE has emphasized transportation biofuels, and we believe this is highly desirable and justifiable.

We are also pleased to note that the Regional Biomass Program request for fiscal year 1992 is a line item for the second successive year, and is significantly higher than it was last year. We recommend again that hydrogen research be deleted from the biofuels research request because it has little or no relationship to biofuels. Hydrogen research will detract from the core biofuels program unless additional funds are provided for this work.

Overall, the Biomass Energy Research Association recommends a funding level of $49.5 million for fiscal year 1992 biofuels R&D, and a balanced program of production, conversion, and technology transfer.

We also recommend that demonstration projects be added to the research program so that industry cost-share and scale up work can be initiated as early as possible to ensure industry participation and transfer of the research results to the private sector.

I now would like to very briefly summarize our recommendations for fiscal year 1992.

In the Office of Transportation Technologies, we focus on biomass production, and biochemical and thermochemical liquefaction. Regarding biomass production, land and water-based biomass grown and harvested specifically for biofuels represents a long-term approach to energy plantations that can supply large amounts of fossil fuel substitutes. We recommend that $5.5 million be directed to continue biomass production research.

For biochemical liquefaction, which is the area that covers ethanol fuel, application of the rapidly advancing field of biotechnology to the conversion of low cost biomass to liquid fuels such as ethanol, as I just mentioned, has made great progress and should be continued. We recommend that $11 million be directed to continue biochemical liquefaction research.

For thermochemical liquefaction, research to produce clean, liquid transportation fuels at competitive costs, this is the prime target of this program component and we believe it should be continued because they have made excellent progress to date. BERA recommends that $5 million be directed to continue thermochemical liquefaction research.

In the Office of Utility Technologies, we recommend that thermochemical conversion research be continued on the gasification of biomass to develop advanced process designs and reactor configurations that maximize yields and provide optimum product distributions. This work has already been performed at the laboratory at pilot scales and is ready for demonstration, particularly for power production. We recommend that $5 million be appropriated for these initial evaluations.

In the Office of Industrial Technologies, we have targeted MSW disposal energy recovery systems and chemical production from biomass. For MSW research, we feel that continued research is needed to reduce the emissions of solid waste disposal processes and to characterize the specific pollutants produced under specific operating conditions. For chemicals from biomass, we recommend that research be continued to develop advanced processes that utilize both thermochemical and biochemical conversion methods as well as physical separation and processing techniques. We recommend further that $4 million be directed to continue research on both municipal solid waste disposal and energy recovery and chemicals from biomass residues.

In the Office of Building Technologies, research should be continued to support a modest program on advanced pollution-free wood and pellet-fueled stoves and furnaces for homes and small commercial and institutional buildings. BERA recommends that $500,000 be appropriated for this work.

And, finally, in the Office of Technical and Financial Assistance, the regional programs established by Congress in 1983 should be sustained to help transfer research results to end-users. We recommend that $6 million be appropriated for this activity.

And then, finally, one of the difficulties encountered in commercializing biofuels technology is that industry is not utilized much of the research information developed in this program. It is therefore strongly recommended that specific scale-up projects be initiated with industry involvement and cost-sharing. The BERA board of directors recommends that the first of these demonstration projects be selected from the list that I have supplied in my statement, and DOE should determine the priority. It is recommended that at least one scale-up demonstration project be started in fiscal year 1992 in addition to the medium BTU gasification demonstration that is now underway in Hawaii, and that at least one new demonstration project be funded each year thereafter with industry cost-sharing. A first year budget of $11 million is recommended for this work.

In summary, we recommend that $49.5 million be appropriated for continuation DOE core biofuels program, and that industry cost-share demonstration projects be added to the program.

Thank you very much.

[The prepared statement of Dr. Klass follows:]

Statement of Dr. Donald L. Klass, President
Biomass Energy Research Association

Before the House Committee on Science, Space, and Technology
Subcommittee on Environment

Hearing on Department of Energy FY 1992 Budget Submission
for Renewable Energy Programs

April 9, 1991

This testimony pertains to the Department of Energy research appropriation on biofuels. The Biomass Energy Research Association (BERA) recommends that $49.5 million be provided for biofuels research in fiscal 1992, with the funds allocated in the following fashion. This budget permits the essential research to be performed, and key demonstration projects to be initiated with direct industry involvement and cost sharing.

Cognizant Conservation and Renewable Energy Office	Research Area	Recommended Budget
Office of Transportation Technologies	Biomass Production	$ 5,500,000
	Biochemical Liquefaction	11,000,000
	Thermochemical Liquefaction	5,000,000
		$21,500,000
Office of Utility Technologies	Thermochemical Conversion	$ 5,000,000
Office of Industrial Technologies	Municipal Solid Wastes and Chemicals	$ 4,000,000
Office of Building Technologies	Combustion	$ 500,000
Office of Technical & Financial Assistance	Regional Programs	$ 6,000,000
All Offices	Demonstration Projects	$11,000,000
	Capital Equipment	1,500,000
		$49,500,000

I am Donald Klass, President of BERA. BERA is a non-profit association that was founded in 1982 by biofuels researchers and companies that are conducting biofuels research. Our objectives are to promote education and research on renewable biomass- and waste-to-energy systems that can be economically utilized by the public, and to serve as a source of information on policies and programs for our members and industry.

We appreciate the opportunity again to present BERA's recommendations for the federal biomass and municipal waste research budget. Before presenting BERA's position and recommendations on the fiscal 1992 budget, I would briefly like to point out how biofuels can play an important role in our new National

Energy Strategy and in meeting the requirements of the Clean Air Act Amendments of 1990.

Biofuels Can Help Clean-Up The Environment

It is important to emphasize the role that biofuels can play in achieving a cleaner environment. Usage of biofuels, such as methanol, ethanol, and other oxygenated biomass derivatives, can have a strong beneficial impact on air quality, particularly as alternative liquid transportation fuels.

- The extremely low sulfur content of biomass results in little or no SO_x emissions, the precursor of acid rain.
- Oxygenated biofuels emit very little NO_x, a necessary reactant in the formation of ozone (smog).
- Application of biofuels technologies to waste offers opportunities for combined waste disposal-energy recovery-conservation systems.
- The growth of biomass is the only practical way to remove CO_2 from the air and ameliorate global warming.
- Biofuels are the only energy technologies that can both remove atmospheric CO_2 and reduce the amount of fossil fuels burned.
- Displacement of fossil fuels by biofuels can eliminate or reduce atmospheric SO_x, NO_x, ozone, and unburned hydrocarbon fuels, all of which contribute heavily to sub-quality air.

Relationship to Energy Security

- Biofuels can provide a strategic and distributed network of renewable energy supplies for the United States since agricultural crops and woody biomass as well as industrial and municipal wastes are available continuously throughout the United States.
- By the year 2000, the energy potentially available each year from biomass and wastes is projected to range up to 54.9 quads or about 50% of the total U.S. primary energy demand.
- In 1988, 4% of U.S. primary energy demand was met by biofuels (3.2 quad or 650 million barrels of oil equivalent out of a total consumption of 83 quad).
- Biofuels contribute to all four sectors of the national energy economy: residential, commercial, industrial, and transportation.
- Currently, municipal, industrial, and agricultural wastes have an estimated domestic energy production potential of 15.0 quad/yr.
- Currently, wood and wood wastes have a domestic energy production potential of 25.0 quad/yr.
- Biofuels are import-substitutes for fossil-based liquid, gaseous, and solid fuels.

Relationship to Economic Growth

- Biofuels are the only renewable energy resource that can provide desperately needed local jobs and economic development nationwide for the American farmer.

- Industrial utilization of biofuels supplies local jobs and income such as the 71,000 jobs and one billion dollars in income in the Southeast that resulted from fuel wood usage in 1987, both of which are projected to increase about 30 to 35% by the year 2000.
- At a price of $20 per barrel of oil equivalent, biofuels currently retain in the U.S.A. about $11.0 billion per year that are not expended on oil imports thereby having a strong beneficial impact on our massive trade deficit.
- Biofuels provide excellent regional benefits -- 80 cents of every dollar spent on biofuels in a given region stays in that region, while 80 cents of every dollar spent on petroleum leaves the region.
- Utilization of excess capacity croplands of up to 160 million acres projected beyond the year 2000 could produce up to 10.2 quad per year of energy crops. This could open the way to new food, feed, and fuel product flexibility to provide more stability to market prices, create new markets for the agricultural sector, and reduce federal farm subsidy payments.
- Virtually all basic organic chemicals -- including plastics and petroleum-derived products -- can be manufactured from biomass and wastes thereby displacing and conserving depletable fossil feedstocks.

CONSERVATION AND RENEWABLE ENERGY PROGRAM REORGANIZATION

It has now been about one year since DOE reorganized Conservation and Renewable Energy into five offices - the Offices of Transportation Technologies, Utility Technologies, Industrial Technologies, Building Technologies, and Technical & Financial Assistance. The biofuels projects managed by the former Biofuels and Municipal Waste Technology Division staff are now managed by DOE staff in each of these offices. It is still too early to determine whether this structure is an asset or a liability, but if industry involvement in biofuels development increases and greater commercial utilization of the research results occurs, the reorganization will have indeed been quite beneficial.

There is, however, a potential adverse impact of the reorganization that I would like to briefly discuss, namely, that the "whole may be less than the sum of the previous parts." For example, the Office of Utility Technologies includes projects on several renewable energy technologies - biofuels, wind, photovoltaics, solar thermal, and others. Similar situations can exist in other offices. We must therefore guard against the possibility that the biofuels objectives and priorities are not lost in the bureaucracy, especially when individual managers are responsible for both biofuels research and other research. If that happens, development of several renewable energy technologies may be set back several years.

We have reviewed DOE's proposed fiscal 1992 $36.8-million biofuels research budget, and again find a significant increase in their request to Congress compared to the previous request. The budget proposed for fiscal 1992 is the first to be submitted under the end-use management structure. We are pleased with the detail on the allocation of funds to specific research areas. In their request, DOE has emphasized transportation biofuels, which improve air quality. We believe this is highly desirable and justifiable.

We are also pleased to note that the Regional Biomass Program request for fiscal 1992 is a line item for the second successive year, and is significantly higher than that of last year. We recommend again that hydrogen research be deleted from the biofuels research request because it has little or no relationship to biofuels. Hydrogen research will detract from the core biofuels program unless additional funds are provided.

BERA RECOMMENDS $49.5 MILLION FOR FISCAL 1992 BIOFUELS R&D
A Balanced Program of Production, Conversion, and Technology Transfer

The following represents BERA's recommendations on the research areas and the funding levels we urge you to include in the fiscal 1992 program. We recommend that demonstration projects be added to the research program so that industry cost-shared scale-up work can be initiated as early as possible to ensure industry participation and transfer of the research results to the private sector.

About two thirds of our budgetary recommendation, excluding BERA's scale-up recommendation of $11 million, is allocated to conversion because we believe that it is the foundation of a balanced program to develop advanced innovative systems for the production of clean solid, liquid, and gaseous biofuels. We continue to believe the real potential of biofuels can never be realized without development of efficient, economic, conversion processes.

Our recommendations comprise a balanced program of production and conversion research and technology transfer to the private sector with emphasis on end uses such as alternative liquid transportation fuels and on innovative municipal solid waste disposal-energy recovery systems having superior environmental benefits and minimal emissions. Also, BERA recommends that a majority of the research funds appropriated for fiscal 1992 be contracted to organizations other than national laboratories. This will allow independent U.S. scientists and engineers involved in biofuels research to maintain their skills and improve their expertise, and for the nation to maintain a competitive technological position in the development of alternative fuels.

I would now like to summarize BERA's biofuels recommendations for fiscal 1992.

Office of Transportation Technologies

Biomass Production. Land and/or water-based biomass grown and harvested specifically for biofuels represents a long-term approach to energy plantations that can supply large amounts of fossil fuel substitutes. Considerable progress has been made on efficient short-rotation intensive-culture tree production methods, and on the growth of herbaceous species. Considerable progress has also been made on development of "wood grass," in which carefully chosen tree species are grown in close-spaced plantings and harvested like a perennial grass over short rotations. In addition, research on tissue culture techniques and the application of genetic engineering methods to low-cost energy crop production have shown promise. This work should be continued as an integral part of the biofuels program. It is recommended that research on aquatic biomass be minimized and that emphasis be given to terrestrial biomass species of trees and grasses.

BERA recommends that $5,500,000 be directed to continue biomass production research.

Biochemical Liquefaction. Application of the rapidly advancing field of biotechnology to the conversion of low-cost biomass to liquid fuels such as ethanol has made great progress and should be continued. Process evaluations by experts have identified key opportunities for economic pay-backs with biochemical conversion systems, and new genetic engineering and other emerging biological approaches have made significant advances. Research needs have been identified to increase our understanding of fermentation processes. Future research should be concentrated on conversion of low-cost feedstocks such as lignocellulosic wood wastes by high-yield acid- and enzyme-catalyzed hydrolysis processes, on development of innovative fermentation product separation schemes that have the capability of producing low-cost fuels and by-products, on the development of organisms that can metabolize the hemicellulose components in the feedstocks, and on the utilization of the lignin fractions as octane enhancers and chemicals. Research is also recommended on the use of genetically engineered bacteria that can produce ethanol from low-cost feedstocks at higher rates and yields and on innovative processes for the production of butyl alcohols for conversion to methyl-*t*-butyl ether (MTBE) and ethyl-*t*-butyl ether (ETBE) gasoline additives.

BERA recommends that $11,000,000 be directed to continue biochemical liquefaction research.

Thermochemical Liquefaction. Thermochemical liquefaction research to produce clean, liquid transportation fuels at competitive costs is the prime target of this program component. Laboratory- and pilot-scale research has established the technical feasibility of several advanced liquefaction processes, and basic research has improved our understanding of the mechanisms of conversion. Direct conversion of wood and herbaceous feedstocks via pyrolysis to liquid fuels and their upgrading by advanced catalytic processes to transportation fuels show promise. Chemical blocking reactions for the upgrading and stabilization of liquid pyrolyzates should be investigated to produce product for use as gasoline additives and as octane-enhancing agents. Continued research is expected to increase the overall liquid yields to the point where the gasoline costs are competitive with those of petroleum-based liquids. Thermochemical liquefaction of low-grade biomass for the production of low-cost fuel ethanol or mixed alcohols also shows promise and merits investigation.

BERA recommends that $5,000,000 be directed to continue thermochemical liquefaction research.

Office of Utility Technologies

Thermochemical Conversion. Continued research on the thermochemical gasification of biomass has resulted in the development of advanced process designs and reactor configurations that maximize yields and provide optimum product distributions. This work has been performed at the laboratory and pilot scales and is ready for demonstration, particularly for power production. Direct coupling of advanced biomass gasifiers to steam-injected gas turbines (STIGS) should be evaluated as a potential high-efficiency generation system. An alternative that should also be evaluated is the integration of high-yield biomass pyrolysis liquefaction processes with power generation either in STIGS or combined-cycle STIGS.

BERA recommends that $5,000,000 be appropriated for the initial evaluations.

Office of Industrial Technologies

Municipal Solid Wastes. In combustion research, a need still exists for improved solid waste incinerators that meet environmental requirements and cost goals. Research should be focused on systems that can be used for economic disposal of municipal solid wastes in small communities. Research is also needed to reduce the emissions of solid waste disposal processes and to characterize the specific pollutants produced under specific operating conditions. Other subjects needing additional research are the monitoring and control of combustion effluents, metal behavior in ash, and characterization of the changing waste streams. Since relatively mature industries are involved, this is also an area for cost-shared development and demonstration activities. Biochemical gasification of wastes is unique in that the process can directly produce methane, the major component of natural gas, from the full range of low-cost biomass. Research is needed to develop novel systems that permit higher feedstock concentrations and smaller reactor volumes, and therefore lower capital costs. This research is expected to lead to practical methods for economic production of methane from low-cost biomass. And in the case of feedstocks such as municipal wastewaters, low-cost integrated biomass production-waste stabilization-methane production systems are expected to evolve from continued research.

Chemicals. A wide range of petrochemical substitutes can be manufactured from biomass residues, such as adhesives, plastics, and packaging materials. Research should be continued to develop advanced processes that utilize both thermochemical and biochemical conversion methods as well as pnysical separation and processing techniques.

BERA recommends that $4,000,000 be directed to continue research on both municipal solid wastes and chemicals from biomass residues.

Office of Building Technologies

Combustion. Research should be continued to support a modest program on advanced pollution-free wood- and pellet-fueled stoves and furnaces for homes and small commercial and institutional buildings. Air-pollution problems continue to be of great concern in certain western and eastern areas and stove and furnace efficiencies, catalytic clean-up of flue gases, and automatic operation are important subjects that need additional research.

BERA recommends that $500,000 be appropriated for this research.

Office of Technical & Financial Assistance

Regional Programs. The Regional Programs established by Congress in 1983 are implemented through five separate regions and should be sustained to help transfer research results to end users. The five regions -- Northwest, West, Great Lakes, Northeast, and Southeast -- have similar objectives, chief among them being the utilization of biofuels technologies by the private sector using local resources.

BERA urges that $6,000,000 be provided for the Regional Programs.

All Conservation and Renewable Offices

Demonstration Programs. One of the difficulties encountered in commercializing biofuels technology is that industry has not utilized much of the research information developed in this program. It is therefore strongly recommended that specific scale-up projects be initiated with industry involvement and cost sharing. The BERA Board of Directors recommends that the first of these demonstration projects be selected from these subjects: Methanol Production from Biomass Gasification Technology, Ethanol Production from Best Available Lignocellulose-Based Technology, Electric Power Production from High-Efficiency Biomass-Fueled Gas Turbines, Municipal Solid Waste Disposal-Energy Recovery by Best Available Technology, Pyrolytic Liquid Fuel Production by Best Available Technology, Biomass Gasification-Molten Carbonate Fuel Cell Cogeneration Systems, and Large-Scale, Short-Rotation, Intensive-Culture Tree or Wood Grass Field Demonstrations. DOE should determine the priority. It is recommended that at least one scale-up demonstration project be started in fiscal 1992, in addition to the medium-Btu gasification demonstration that is now underway, and that at least one new demonstration project be funded each year thereafter.

A first-year budget of $11,000,000 is recommended for this work.

Program Planning. DOE's first multiyear plan for biofuels R&D was published in fiscal 1989. BERA recommends that the plan be updated in fiscal 1992 and that program elements described in the plan related to past, present, and planned funding levels.

Mr. **Scheuer**. And now we will hear from Mr. Randall Swisher, executive director of the American Wind Energy Association. Please proceed.

STATEMENT OF RANDALL S. SWISHER, EXECUTIVE DIRECTOR, AMERICAN WIND ENERGY ASSOCIATION, WASHINGTON, DC

Mr. **Swisher**. Thank you, Mr. Chairman. I appreciate the opportunity to be here this morning. Let me begin with a brief summary of the current status of wind energy technology before moving to comments on the fiscal year 1992 budget request and the National Energy Strategy.

Today, there are approximately 16,000 wind turbine connected to the electric grid, providing about 1600 megawatts of electric capacity, primarily in California. Last year, wind generated 2.5 billion kilowatt hours of electricity. That would serve the residential needs of almost a million people. At times, wind-generated electricity provided as much as 8 percent of the load for Pacific Gas and Electric Company, the country's largest private utility.

As far as the performance of wind energy technology, there is no question that wind had a difficult birth in the early 1980's. The first wind farms went in in 1981 in California. But after a series of stops and starts, dramatic evolution of the technology over the last decade in which we have seen the production per turbine quintupled over a six year period. We have seen the availability of wind turbines go from about 50 to 60 percent in the early 1980s to over 95 percent today. That compares favorably with any conventional technology.

Costs have declined in the last decade 75 to 80 percent, putting them in the competitive range with conventional fuels. We expect those costs to decline another 40 to 60 percent in the next decade. According to Pacific Gas and Electric in an analysis they produced last year, they expect wind energy technology to be their cheapest source of new power supply by the end of the decade.

Wind energy is not a marginal resource. There is sufficient wind potential in 37 of the 50 States to provide utility power plant generation. According to a study performed last year for the Department of Energy, approximately three times the amount of the country's total electric demand is available in terms of wind energy potential.

Around the world, particularly in Western Europe, there is a growing recognition of the importance of this technology. Western Europe has made a commitment to approximately 4,000 megawatts of wind capacity by the end of the decade. They are investing ten times as much as the United States in R&D. They are providing market incentives in Germany and in the Netherlands of about 4.5 cents per kilowatt hour. They have made a major commitment to wind, and I expect them to be making very dramatic progress.

In addressing the fiscal year 1992 budget request, the $13.9 million requested by the Administration was a significant increase over last year. That amount, however, is dwarfed by the amount being invested by our international competitors and it is inadequate to make the kind of near-term progress that we feel needs to be made on projects like the advanced wind turbine. We are requesting, asking the committee for $22 million in authorization for fiscal year 1992, with $7 million devoted to the advanced wind turbine project. We would ask that the committee on science increase the authorization for wind energy to that $22 million figure in fiscal year 1992.

Mr. SCHEUER. That was from what?

Mr. SWISHER. That is from a request of $13.944 million put forward by the Administration.

Mr. SCHEUER. Thank you.

Mr. SWISHER. In terms of the National Energy Strategy, we were very disappointed by the Administration's proposal. The one part of the package that we deemed most important—production incentives for wind and other renewable technologies—was dropped by the White House despite the recommendations of the Department of Energy. It is clear to me that there is a broad consensus on the importance of increased R&D for wind and other renewable technologies, and that is the one thing that the NES held forth for renewables. What they project is a long-term picture, gradual increasing dependence on renewable energy. The real question is how quickly do we want to realize the potential of wind and other renewable technologies. If you look at what was requested by the NES, it is clear that there is nothing proposed in terms of wind energy that promises to have an impact on the markets in the near term.

Look at the record. There are a range of renewable technologies that are cost competitive today and that have extremely reliable performance. What is necessary is not simply increased R&D, but policy recommendations and decisions that will have an impact on market and regulatory barriers to move these technologies into the market in the near term. The National Energy Strategy should have included a range of proposals, including a long-term commitment to Federal incentives for wind and other renewable technologies.

Regulatory reform is needed, at the State level in particular, but it is a big enough issue that it requires Federal leadership.

Third, lower cost capital for renewable technologies. A renewable energy financing authority.

Fourth, transmission access for renewable projects will be extremely important to realizing the potential of these technologies.

And fifth, an active Federal role in removing the information barriers existing to these technologies which are evolving so rapidly that decision-makers, whether in utilities or regulatory commissions, simply are unable to keep up with the rapidly evolving nature of the technologies.

Thank you very much.

[The prepared statement of Mr. Swisher follows:]

American Wind Energy Association

TESTIMONY OF
RANDALL S. SWISHER, EXECUTIVE DIRECTOR
AMERICAN WIND ENERGY ASSOCIATION

BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

APRIL 9, 1991

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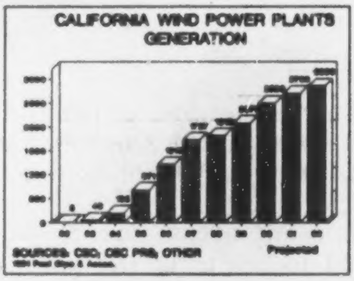
I appreciate the opportunity to appear before you today on behalf of the American Wind Energy Association (AWEA) to provide an update on the current status of wind energy technology and AWEA's recommendations on the Department of Energy R&D budget and on federal actions that could encourage private sector investment in wind and other renewable technologies.

A decade ago, wind energy technology was simply not an option for bulk power generation for utilities. At that time, there was no such thing as a wind power plant or "windfarm." Today, in contrast, there are **over 18,000 "utility-scale" turbines averaging 100 kW in size** connected to the grid worldwide, representing about **1,800 MW**, with more than 80 percent of that capacity installed in California. There are also about 5,500 small turbines of 10 kW or less in the United States, with 4,500 connected to the grid.

The birth of the wind energy industry was unquestionably difficult. Technical breakdowns were a common occurrence in the early Eighties. When the federal tax credits for wind energy were abruptly ended in 1985, many companies went out of business. But the survivors persevered, and over the last five years the wind industry has come into its own, demonstrating reliable performance in an astonishingly short period of time. Unfortunately, too many utilities and utility regulators have an image of wind energy technology that is about five years out of date, unaware of the rapid evolution of the wind industry.



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For example, the California wind industry generated only 6 million kWh in 1982. **In 1990 wind generated 2.5 billion kWh** of electricity in the state, more than enough to serve the residential needs of the city of San Francisco. Average wind turbine productivity increased from about 36,000 kWh per year for each turbine in 1983 to 160,000 kWh per year in 1989.

The technical reliability of wind turbines was a major concern in the early Eighties, and some in the utility industry continue to express skepticism about turbine performance, but the documented progress of the last five years has definitively answered questions about wind's technical performance. Wind turbine availability--a measure of technical reliability--was no more than 60 percent in 1981-82, but most wind turbines installed in the last five years are available to generate electricity more than 95 percent of the time. In other words, generally the only down time for current wind technology is for periodic maintenance, which is scheduled for times of low wind speeds.

Wind power costs have also shown remarkable progress, declining from about 25 cents per kWh in 1981 to between 6 and 9 cents today (depending primarily upon the wind speeds at a particular site). It should be remembered that these costs are being achieved with relatively short-term financing of 8 to 10 years, at high interest rates, imposing a high debt burden in the first ten years of a project. Wind energy costs would be appreciably lower if long-term utility financing were available.

Regardless of the type of financing available, Robert Lynette, an insightful analyst of wind technology, estimates that wind energy costs should continue to decline by an additional 40 to as much as 60 percent over the next decade because of technical improvements and application of advanced designs. Pacific Gas and Electric, one of the world's largest purchasers of wind-generated electricity, has concluded in a paper published in 1990 that "wind energy will become the most economic new base load source by the year 2002 under the expected fuel cost scenario, and by 1992 under the high fuel cost scenario."

Capital costs for wind systems are now as low as $1000 per kW of capacity, and costs for operations and maintenance are about a penny per kWh. In an era when some fossil fuel costs have been showing roller coaster volatility, it is important to remember that the fuel costs for wind energy are free. Wind energy companies are thus able to credibly guarantee long term price stability, with inflation the only escalator.

In one of the nation's most comprehensive evaluations of energy technologies, the 1990 Energy Technology Status Report, the California Energy Commission found wind energy to be one of the least cost sources for new electricity generation when similar utility financing is made available to each technology. When social or environmental costs are considered, wind energy becomes even more attractive in comparison to conventional sources.

COST OF NEW ELECTRICAL GENERATION
IN CONSTANT 1987 DOLLARS

	Low	High
Solar Thermal Hybrid	6.0	7.8
Nuclear	5.3	9.3
Natural Gas (Intermediate)	5.3	7.5
Hydro	5.2	18.9
Wind	4.7	7.2
Coal Boiler	4.5	7.0
Natural Gas Combined Cycle	4.4	5.0
Geothermal Flash Steam	4.3	6.8
Biomass Combustion	4.2	7.9

Cents/kWh

Source: California Energy Commission 1990 ETSR

In less than a decade, therefore, wind energy technology has evolved to the point where it is technically reliable and cost-effective--no longer an exotic technology for the future, but ready to join the ranks of today's utility technologies.

Although California is home to 80 percent of the world's installed wind capacity, wind technology's potential has been recognized around the world. The European Community has a goal of 4,000 MW of wind capacity by the end of the decade, has a wind R&D budget ten times as large as that of the U.S., and countries such as Germany and the Netherlands are providing incentives of about 4.5 cents/kWh to help stimulate the technology. In addition, Mitsubishi has entered the California wind market in a major way, and clearly intends to be a long-term player in the wind industry.

WIND ENERGY IS CLEAN ENERGY

Along with the fact that wind is a renewable fuel, there is still one other important point distinguishing wind energy from the so-called conventional technologies: wind energy technology is as pollution-free as any electricity supply technology available today. The air pollution benefits are particularly notable. Last year alone, California wind generation offset the emission of more than 2.5 billion pounds of carbon dioxide, and 15 million pounds of pollutants such as SO2 and NOx. It would take a forest of between 90 million and 175 million trees to provide the same air quality benefit.

Although wind energy is deemed by many to be a land-intensive technology, 95 percent of the land in a "windfarm" or wind power plant remains available for compatible agricultural uses. In California, it is not unusual to see livestock grazing among the turbines, and in Europe there are examples of fields being tilled right to the base of the wind turbines.

For farmers struggling to survive, additional income from wind energy land leases can be a godsend, ranging from $160 to $400 per acre in California. For many rural areas of the American West and Great Plains, wind energy represents a home-grown industry for clean energy export that offers great economic development possibilities, with five times the job creation potential of either nuclear or coal (even when including mining jobs) per unit of electricity generated.

WIND ENERGY OFFERS IMMENSE POTENTIAL

Wind energy is not a marginal resource. Thirty seven of the 50 states, according to the Department of Energy, have sufficient wind resources to support development of utility wind power plants. A recent study by the Pacific Northwest Labs for the Department of Energy concluded that even after making substantial exclusions for environmentally sensitive lands or other incompatible land uses, there are still sufficient areas--about 1.5 percent of the contiguous United States--possessing annual wind averages over 16 miles per hour (Class 5 winds) to provide at least 25 percent of our current electric demand. Four states have more Class 5 wind potential than California: North Dakota, Wyoming, Montana and Nevada.

The Pacific Northwest Labs study found that there were about 10 times as many lands that were characterized by 14 mile per hour average winds (Class 3) as 16 mile per hour winds. These winds are less energetic but will be cost-effective to develop with the next generation turbines that will be coming into the market in the 1993-95 timeframe. These Class 3 winds, which are typical of the Great Plains from Texas to the Dakotas, have the potential, according to PNL, of over 100 quads of energy. (Total energy use in the United States in 1988 was only 82 quads, with 36 percent of that devoted to the production of electricity.)

AWEA does not expect all of this huge potential for wind energy to be developed, nor will massive wind energy development occur overnight. Wind is an intermittent resource, and wind technology must therefore today be integrated with other baseload power sources to provide a stable utility system. However, the scope of the resource makes what would today appear an ambitious goal quite realistic.

A realistic goal for U.S. energy policy is for wind energy to provide 20 percent of U.S. electric capacity within the next three decades. That goal could be achieved with present or next generation technology. However, as energy storage technology improves, as electric vehicles become increasingly prevalent, or as hydrogen technology evolves, the applications for wind-generated power expand substantially. In the face of such technological advances, the issue of wind's intermittency will diminish, and the enormous wind energy potential identified by PNL will become a national resource with profound energy policy implications.

Despite California's status as world leader in wind energy, when Class 3 and above wind potential is evaluated, there are 16 states that possess wind energy potential equal to or greater than California's. They are, in order of greatest potential: North Dakota, Texas, Kansas, Montana and South Dakota (tied), Nebraska, Wyoming, Oklahoma, Minnesota, Iowa, Colorado, New Mexico, Idaho, New York, Illinois and Michigan.

North Dakota and Texas are virtual "Saudi Arabias of wind energy," with each having sufficient wind potential to provide more than 2/5 of current U.S. electric needs. The wind electric potential for each state, according to PNL, is the equivalent of over two billion barrels of oil annually.

INTEGRATING WIND TECHNOLOGY INTO TODAY'S UTILITY SYSTEMS

Some utility engineers are uncomfortable with wind energy technology because it is not "dispatchable." Wind energy may be intermittent (Carl Weinberg of PG&E refers to it as "naturally dispatchable"), but that does not mean the wind energy resource is unpredictable. In fact, in most regions, unless the winds are driven primarily by storm fronts, the winds follow highly predictable patterns on both a daily and a seasonal basis.

For example, in California 80% of the wind-generated electricity is provided between May 1 and October 31, which fortunately coincides with the utilities' seasonal peak demand. As PG&E has reported, "there is a good seasonal fit to PG&E needs, as the wind power plants produce most of their output during the second and third quarter of the year, when PG&E's loads are greatest."

Daily wind patterns also follow a predictable course, but will vary considerably from one region to another. In Altamont Pass, PG&E has found a daily coincidence with peak of about 40 percent, but the winds in the nearby Solano area offer as much as an 80 percent match with the utility's daily peak.

The key point is that once states further study and understand the nature of their wind resource it can usually be integrated into their utility system fairly easily and with a high degree of predictability. The reliability of wind power plants has also been enhanced by their modular nature: if one turbine goes down, the other turbines in the wind system are still available to generate electricity.

Some utilities also have expressed concern about the power quality associated with wind-generated electricity or about the difficulty of integrating wind power plants into already complex transmission systems. Most informed observers have been surprised at how relatively easy it has been to integrate wind-generated electricity into the California utility system, presenting occasional engineering challenges but nothing remotely resembling a "show-stopper." The California utilities have established operating, metering and equipment protection requirements for wind power plants that are interconnected with their systems, and those requirements have been met.

At times, wind energy from the Altamont Pass has provided as much as 8 percent of PG&E's electric load. But, as PG&E's Bill Steeley has noted, "To our knowledge **there have been no system stability problems from the wind power plants."**

FY '92 BUDGET REQUESTS

The Administration's FY '92 request for wind energy was $13.944 million, up from $11.2 million the preceding year. This is a substantial percentage increase, but the total sum is dwarfed by the levels being invested in wind technology in Europe--approximately $140 million in 1990. It is also substantially below what is needed to develop next generation wind technology on a timeline to compete in international markets in the mid-90s.

AWEA has recommended DOE wind energy funding of $22 million for FY '92, with $7 million devoted to the Advanced Wind Turbine project. The AWEA request calls for slight funding increases for the national labs to direct the long-term R&D, with greater emphasis and budgetary growth devoted to cooperative R&D or other commercialization activities.

AWEA requests that the Committee on Science, Space and Technology increase the authorizations for wind energy to $22 million for FY '92 and to $37 million in FY '93 to accommodate the needs of the Advanced Wind Turbine project and other public/private initiatives.

The Advanced Wind Turbine Initiative

The Advanced Wind Turbine project should be funded at a level of approximately $35 million over the next three years. This project is designed to develop a number of commercial prototypes of advanced technology by the mid-90s, with the goal of achieving targets of five cents per kWh in moderate wind regimes of 13 miles per hour. This would open up three quarters of the states, including vast areas of the Great Plains, to commercial wind development. Today, wind technology is able to achieve the five cent target only in a few of the most outstanding wind sites--those exceeding 18 miles per hour.

Public/Private Joint Ventures

The Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989 (P.L. 101-218) authorized development of renewable energy joint ventures as a way of moving these new technologies more rapidly into widespread commercial application. The legislation has never been fully funded although DOE requested $1 million for such joint ventures in wind energy in FY '92. One may measure the adequacy of that request by comparing the cost of the most recent California wind project: the 77 MW Sky River project will cost approximately $167 million, including substantial transmission development.

If the federal government is serious about using the joint venture concept as a vehicle to achieve more widespread commercial applications of renewable technologies, funding for such an initiative must be realistically aggressive, on a scale mirroring the Clean Coal Technology Initiative. AWEA is recommending $800 million over five years on a multi-technology basis for renewable energy joint ventures.

Hybrid Systems

A large and virtually untapped international market exists for non-utility grid connected systems to provide power in developing countries. This would include wind-diesel hybrids, wind-photovoltaic systems or other hybrids. Hybrid systems deserve more coherent program development by DOE if we hope to take advantage of this emerging international market, and AWEA is recommending $1 million for the FY '92 wind budget for hybrid systems.

Small Wind Turbines

There is a significant international market for small wind turbines (up to 50 kW) designed for off-grid applications such as remote village electrification or water pumping. AWEA recommends $500,000 for FY '92 to support cost-shared cooperative research with industry in order to apply advanced technology so as to reduce the cost and increase the competitiveness of American technology.

Transmission Studies/Electric Energy Systems

Substantial wind energy development will require a transmission plan that identifies new or upgraded transmission capacity that will be required to access major wind resource areas in the U.S. AWEA is recommending $1 million for FY '92 within the Electric Energy Systems budget to initiate cooperative analysis with the Power Marketing Administrations to evaluate access to existing lines and siting of new lines to encourage development of renewable energy systems, focused in particular on those technologies capable of supplying utility grade power such as wind, geothermal and solar thermal.

Energy Storage Systems

Cost-effective energy storage systems are essential for intermittent renewable technologies such as wind and solar to achieve their full potential, but DOE has not placed adequate emphasis on "firming" such renewable technologies in their storage R&D. AWEA supports $8 million in FY '92 as a set-aside for renewable energy battery storage programs, with half of that devoted to renewable energy hydrogen applications.

Resource Assessment

AWEA supports $5 million for renewable energy resource assessment work to prepare both domestic and international resource maps for wind and other renewable technologies, with at least $500,000 provided to Battelle Pacific Northwest Laboratory to conduct wind resource data collection and analysis in cooperation with industry.

Certification

To compete in the emerging international markets, it will be important for performance of U.S. wind turbines to be certified by a technically qualified source. AWEA recommends that $2 million be provided to the Solar Energy Research Institute to establish a wind turbine certification facility in cooperation with U.S. industry.

Power Marketing Administrations

The Federal Power Marketing Administrations (Bonneville Power Administration, Western Area Power Administration, etc.) market power from federal dams to distribution utilities in 34 states. Federal hydro power is completely allocated, and additional demand will have to be met through new sources. The Conservation and Renewable Energy Program which is required of WAPA and their distribution utilities under the Hoover Power Plant Act of 1984 should be extended to the other PMAs, and broadened to encourage greater utilization of renewable technologies, including a target that 20 percent of new capacity developed by each distribution utility be from non-hydro renewable technologies.

NATIONAL ENERGY STRATEGY

The American Wind Energy Association was very disappointed with the Administration's proposed National Energy Strategy. Energy decisionmaking in this country is biased toward conventional fuels through a whole host of subsidies and regulatory advantages, and the NES did nothing to level the playing field. The one proposal the wind industry deemed most important--production incentives for renewable technologies--was dropped despite the recommendation of the Department of Energy. Despite the painful lessons of the past, the "strategy" contains no plan to move aggressively toward greater reliance upon clean, renewable technologies.

To be fair, AWEA recognizes that this Administration has reversed some trends of the last decade, and that renewable energy R&D funding is no longer heading steadily downward. Thankfully, commercialization is no longer a "dirty word" at the Department of Energy, and a much closer working relationship is developing between DOE, the national labs and the wind industry.

Increased R&D will contribute to continued cost decreases for wind-generated electricity of between 40 and 60 percent over the next decade. This should bring wind energy to a cost of around 4 cents per kWh in excellent wind regimes, and approximately 5 cents in moderate wind sites typical of the Great Plains.

At that price, wind applications should steadily expand in many parts of the country, but in the near term we see only limited market activity without aggressive leadership at the federal and state levels. In other words, while increased R&D is essential to achieving the technical advances necessary to realize wind energy's potential, that potential will only be slowly achieved without energy policy leadership designed to open up markets for renewable energy technologies. Aside from increased research and development funding, there are at least five other areas the National Energy Strategy should have addressed to spur more rapid renewable energy development.

1) Federal Incentives

Conventional energy technologies receive substantial subsidies, and the oil and gas industries received an additional $2.5 billion in last year's reconciliation package. Wind energy equipment, in contrast, has not been eligible for federal tax credits since 1985. Federal incentives for wind energy development are essential to send a message to private markets that there is a genuine federal commitment to widespread application of wind energy technology. Although there is substantial wind engineering talent in the United States, and there are at least half a dozen efforts underway to develop advanced wind technology, investment capital for those efforts will be constrained unless there is greater clarity about the place of renewable technologies in federal energy policy. The proposed National Energy Strategy, unfortunately, did nothing to encourage greater investment in renewable technologies.

AWEA is recommending a federal production incentive for wind and other renewable technologies of 2.5 cents per kWh, similar to that proposed by Energy and Power Subcommittee Chairman Phil Sharp in H.R. 780, the Renewable Energy and Energy Efficiency Tax Act of 1991, or H.R. 1543, the Comprehensive Energy Policy Act of 1991, introduced by Rep. Norman Lent, ranking minority member of the Energy and Commerce Committee. As was mentioned above, a production incentive for wind and other renewable technologies was also recommended by the Department of Energy for the NES, but it was deleted from the final document by the White House.

2) Regulatory Reform

A recent report of the National Association of Regulatory Utility Commissioners concluded that "existing state regulatory rules and practices unintentionally produce biases against renewable energy resources. As a result, renewable resources often fail in competition with more traditional resources even though they are more cost-effective."

Regulation that is sensitive to the unique characteristics of renewable technologies is essential to developing financeable renewable contracts. Although primarily a state issue, federal leadership is important to achieving regulatory changes of such scope.

3) Cost of Capital

If conventional utility financing--characterized by a term of 20 to 30 years--were available for wind projects, the costs of wind-generated electricity would be approximately the same as coal or gas-fired electricity. Unfortunately, as relatively new technology, wind projects must be financed over much shorter terms of eight to ten years, making debt payments in that period high and rendering many projects not viable. Solution: a federal Renewable Energy Financing Authority that would make lower cost capital available, combined with more sensitive and creative state regulation allowing standard contracts for renewable projects, with payments front-end loaded to correspond with debt payment requirements

4) Transmission Access

Renewable energy projects need access to transmission lines to be able to deliver power to major demand centers. Any changes in the Public Utility Holding Company Act should be accompanied by cost-based access to the nation's transmission lines for wind and other renewable energy project developers.

5) Information Barriers to Renewable Energy Development

Lack of current information about rapidly evolving renewable technologies has lead to outdated perceptions about the cost and reliability of renewables. Aside from the difficulty of keeping up with the dramatic improvements in technology, the characteristics of renewables are also fundamentally different from conventional technologies. Sound decisions about utility supply options demand a detailed understanding of renewable technologies and their operating characteristics, especially for utility managers and regulators, and requires a much more active federal role in renewable energy technology transfer and in educating key audiences about the current status of renewable technologies.

On behalf of the American Wind Energy Association, I appreciate the opportunity to appear before you today. With increasing concerns about energy security, the global environment and international competitiveness in high technology markets, it is clear that the 1990s require a strong federal commitment to a dramatically enhanced role for renewable energy technologies. Wind and other renewable energy technologies are ready today to contribute to America's energy needs. The speed with which we realize America's renewable energy potential will be largely defined by policy decisions made in the next few years. We appreciate the Committee's support in helping to make wind energy a significant contributor to America's energy needs.

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*In 1976-78 developed and taught "Energy and the American Way of Life" and "Energy, Utilities and the Public Interest."

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Mr. SCHEUER. Thank you very much, Mr. Swisher, for your stimulating testimony.

Now I would like to recognize Mr. Kent Burton, director of the Institute of Resource Recovery of the National Solid Waste Management Association. And I take particular pleasure in welcoming Kent Burton back to this subcommittee. He appeared here many times as under secretary of Commerce, giving us policy guidance on the National Weather Service and other elements in the National Oceanic and Atmospheric Administration. He has always been a thoughtful and stimulating witness for Government at the highest levels. We welcome his rebirth and reemergence as a thoughtful and creative spokesman for free enterprise forces.

Welcome back, Kent Burton, and let's hear from you.

STATEMENT OF B. KENT BURTON, DIRECTOR, INSTITUTE OF RESOURCE RECOVERY, NATIONAL SOLID WASTE MANAGEMENT ASSOCIATION, WASHINGTON, DC

Mr. BURTON. As usual, Mr. Chairman, you are more than effusive; nonetheless, I appreciate your thoughtful and generous comments. It is a pleasure to be back before the committee in this new capacity.

Just a word or two perhaps regarding the IRR, and then the state of the industry in the waste energy field, and then comments also on the National Energy Strategy and other things.

The Institute of Resource Recovery, number one, is the trade association representing the waste energy industry. We have seven major companies that are doing business as full service vendors in the area of waste energy, manufacturing, building, and operating facilities that combust waste for purposes of producing energy to put on the utility grids. There are about 130 such facilities operating around the United States today, and that represents about 17 percent of the solid waste that is produced in this country. The growth of the industry over the last several years frankly has been rather dramatic. As late as 1983, there were only 50 such facilities. Previous to that, in the late 1970s, there were perhaps 20 or so is all, up to 130 today.

In comparison, however, to other countries, I should note that we are catching up in the use of this technology. It has only been around in its modern state for about the last 15 years. Japan, for instance, uses modern waste energy technology with air pollution control equipment and, again, energy recovery technology to the tune of about 50 percent of the solid waste that is produced in that country. In Europe, the number is around 40 percent. We think there is a long way to go in terms of exploiting the potential for using this technology. And, frankly, the National Energy Strategy notes that. The National Energy Strategy notes that overall we are producing as an industry today about .4 quads of electricity, and that's about 2,000 megawatts, which is significant in the area of renewable energy. But again, compared to the potential the industry has, it is short of that.

Indeed, the National Energy Strategy calls for this industry to grow about seven-fold from that .4 quads to 2.1 quads by the year 2010. We are heartened by that endorsement that the Strategy has given us, but we think that there are shortcomings and roadblocks, obstacles, that need to be overcome before we can get there. Let me just perhaps note a few of those as I close here, I know the time is late.

For starters, we think that the waste energy industry needs to be loosed from the current cap of 80 megawatts which is currently placed on us by the Public Utilities Regulatory Policy Act, PURPA. That hampers the ability of the industry to be as efficient as we can be. I might note the fact that, for example in this local area, Fairfax, Virginia, has a facility that combusts for energy production about 3,000 tons per day. It is operating at the capacity of 79.99 megawatts. It could be more efficient. More steam could be captured, more electricity produced if the arbitrary cap of 80 megawatts were lifted. We think that ought to be done, and we endorse that recommendation that's in the National Energy Strategy to take care of that problem, not only for the waste energy industry but other renewable forms.

Second, in addition to removing the PURPA cap, we think waste energy facilities should be afforded a priority status under PURPA. Under current law, the waste energy industry competes on equal footing against fossil fueled power plants, another technology whose sole purpose is to generate power. As I noted previously though in my written statement, our industry serves the primary purpose of helping local communities in the Nation manage solid waste in an environmentally sound manner. Since it is critical for this industry to continue to help solve our Nation's solid waste problem, the power produced by these facilities should be given a priority status over other competing sources, particularly fossil fuel sources.

Under our current restrictive policy, some of the power that is generated as an outgrowth of solving the solid waste problem simply is vented and vanishes into thin air. We think a sound policy for the country would allow for the maximum use of the power generated by this waste combustion.

Third, we suggest that reform is needed with regard to the provisions of existing law that now limit State regulatory authority to set energy purchasing rates. Under current law States don't have the authority to require utilities to purchase power from waste energy plants or other renewable sources at rates that are higher than avoided cost. This policy has overturned several State statutes and decisions which had sought to encourage alternative energy sources in this manner.

Finally, we are going to be dealing with RCRA, the Resource Conservation and Recovery Act. We will need to work with Congress to make sure that this industry receives balanced treatment in conjunction with recycling and waste reduction and ash treatment.

Mr. Chairman, we are encouraged at the prospects for increased growth of this renewable energy technology. We think there are some roadblocks that need to be overcome, and look forward to working with the committee and Congress to help solve them. Thank you very much. It's good to be back.

[The prepared statement of Mr. Burton follows:]

IRR

Institute
of Resource
Recovery

TESTIMONY OF KENT BURTON, DIRECTOR

INSTITUTE OF RESOURCE RECOVERY

BEFORE THE HOUSE SUBCOMMITTEE ON NATURAL RESOURCES,

AGRICULTURE RESEARCH AND ENVIRONMENT

APRIL 9, 1991

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TESTIMONY OF KENT BURTON, DIRECTOR
INSTITUTE OF RESOURCE RECOVERY
BEFORE THE HOUSE SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT
APRIL 9, 1991

INTRODUCTION

I am Kent Burton, Director of the Institute of Resource Recovery. Thank you for the opportunity to testify before the Subcommittee today. I am testifying on behalf of the Institute of Resource Recovery (IRR). The IRR is comprised of firms that design, build and operate facilities to recover energy and materials from trash while reducing its volume through controlled combustion. The Institute is a component of the National Solid Wastes Management Association, a trade association with over 2,500 members of the private waste services industry.

We congratulate the Committee for its leadership in encouraging the development and use of renewable energy in this country. As we move toward this important objective, waste-to-energy (WTE) has an important role to play. The IRR is encouraged to see that this technology has been included in the National Energy Strategy. The Institute is hopeful that current obstacles, which I will describe momentarily, can be removed to allow for the maximum potential of WTE.

THE INDUSTRY TODAY

For nearly two decades, the IRR has been the foremost advocate of incorporating WTE technology into an integrated solid waste management solution. The facilities our members operate account for more than half of capacity of major WTE projects built in this country since 1985. More than two-thirds of the capacity of major WTE projects now under construction is being built and will be operated by our members. IRR members also include municipalities with WTE plants in operation or under construction as well as companies that provide legal, financial, engineering and construction services to our industry.

WTE is growing dramatically in the United States. In 1983, 50 facilities burned 7.6 million tons of trash. In 1986, the number of plants grew to 81, and the amount of trash processed expanded to almost 12 million tons. This year, 130 WTE facilities in 38 states will burn 27 million tons of trash. Projects under construction, plus those in the planning stage, could bring the total WTE capacity available in the country to over 58 million tons a year. That's 30 percent of the trash this country will generate. Altogether, these facilities will represent a capital investment by communities of over $17 billion. With the permission of the committee I will submit for the record a recently released report on the status of the North American industry.

Waste-to-energy technology is not, however, unique to North America. In Japan, close to 50 percent of the waste stream is combusted for energy recovery. In western Europe, countries manage an average of 40 percent of their garbage through municipal waste combustion.

Here in America, our waste services industry is committed to the management of solid waste in an environmentally protective manner. It is important to remember, however, that the first and foremost reason to manage solid waste is to protect public health. We manage our trash to avoid the spread of disease and to prevent contamination of our surface and ground water resources. We hope to perform this essential public service in a way that optimizes the recovery of marketable materials and of energy value from our waste. But we must not lose sight of our primary goal: to protect public health.

WASTE-TO-ENERGY AS A VIABLE RENEWABLE ENERGY SOURCE

WTE is an important source of renewable energy in the U.S. with a tremendous potential for playing a more significant role in the future. This is made clear in the President's National Energy Strategy (NES). While WTE plants currently generate approximately .3 quads (300 billion Btu) of energy annually, NES actions aimed at encouraging this technology are expected to result in up to 2.1 quads of energy for electric generation by the year 2010.

Stated differently, the 130 WTE plants now in operation will produce the energy equivalent of more than 40 million barrels of oil, or an equivalent amount of electricity for over 1.2 million homes. By the end of 1995, WTE facilities are projected to recover the energy equivalent of nearly 90 million barrels of oil each year.

To accomplish the 2010 objective, the NES calls for the Department of Energy (DOE) to collect and disseminate economic, engineering, and environmental data in collaboration with the Environmental Protection Agency, States, local jurisdictions, industry, and public interest groups. Such information will cover both municipal solid waste projects and related technologies such as recycling, landfilling, and displaced energy sources.

The IRR is fully supportive of the drive to promote renewable domestic energy sources as a meaningful part of the NES. The President's endorsement of an expanded role for WTE toward this objective is an important first step. I would also like to note the NES acknowledgement that, although many see fuel requirements of WTE facilities as competition for recycling programs, in fact, WTE and other waste management options like recycling can be very compatible components of a comprehensive program.

WASTE-TO-ENERGY GROWTH OBSTACLES

There are, however, several issues to be addressed to allow for full realization of the forecasted energy potential of WTE. For starters, WTE facilities are currently subject to a restrictive power generation cap of 80MW under the Public Utilities Regulatory Policy Act (PURPA). The NES recommends removal of this cap for these and other alternative energy facilities. We support this recommendation.

Second, in addition to removing the PURPA cap, WTE facilities should be afforded a priority status under PURPA. Under current law, WTE competes on equal footing against fossil fuel-powered plants and other technologies whose sole purpose is to generate power. As I noted previously, WTE plants serve the primary purpose of helping local communities and the nation manage solid waste in an environmentally sound manner. Since it is critical for WTE to continue to help solve our nation's growing solid waste management dilemma, the power produced by WTE facilities should be given a priority over competing sources. Under our current restrictive policy, some of this power is literally vented and "vanishes into thin air." A sound energy policy would allow for the maximum use of the power generated by waste combustion.

Third, the IRR suggests that reform is needed with regard to provisions of existing law that limits state regulatory authority to set energy purchasing rates. Under current law, States do not have the authority to require utilities to purchase power from WTE plants at rates higher than avoided cost. This policy has overturned several state statutes and regulatory decisions which had sought to encourage alternative energy sources in this manner. A reversal of this policy is necessary in order for WTE to realize the potential envisioned by the NES.

Finally, Congress will be addressing how America will be dealing with solid waste in the future in its debate over the reauthorization of the Resource Conservation and Recovery Act. The IRR believes that important issues relating to WTE can, and should, be addressed as part of this debate. These include integration of WTE with recycling and waste reduction, and ash management requirements. We look forward to working with the members of this Subcommittee to assure that these issues are addressed objectively and on the merits during the course of this debate.

DOE BUDGET

The IRR is encouraged to see that funding has been requested by DOE for renewable energy research and development (R & D). While the $1.5 million approved to cover FY 1990 & 1991 and the $6.3 million requested for WTE-related activities in FY 1992 is a good starting point, more may be needed to address the issues noted in the NES. Of particular importance will be research and development programs aimed at further improving WTE technologies and resulting in wider WTE use.

CONCLUSION

The IRR stands ready to assist the Subcommittee on this important matter. WTE has a critical role to play as part of our nation's NES and we look forward to working with you and the Administration to encourage its growth as well as the use of other proven renewable energy technologies.

Thank you for the opportunity to appear before you today and I would be happy to answer any questions.

Mr. SCHEUER. Welcome back, Kent Burton.

OK. Dick Swett. [Laughter.]

Mr. SWETT. What a dialogue. Thank you, Mr. Chair.

I will start on a personal note. I feel like I'm at one of those energy trade fairs, and that's particularly important to me because as an energy developer and as an architect, I had the opportunity of attending many of these, whether it was dealing with architectural materials, units that can be employed in residential energy production, or co-generation and large-scale energy production. I happen to be in the process of looking for and purchasing a new house and I am going to be devoting some of my resources to incorporating the technologies that you have spoken of. I think photovoltaics and wind power are interesting. I don't know if I can use a waste energy facility. I don't know that I generate that much garbage, although I have five children. [Laughter.]

Maybe their broken toys will give me a few KW.

We have a broad spectrum of things to discuss and it is going to be a little difficult sort of sifting through all of the very commendable remarks that each of you gentlemen have given to us this morning. What I would like to do is just try and pick over several notes that I have taken and hopefully pick out some important points that I think need to be discussed a little further.

For starters, when I talk to people in my congressional office and as I travel throughout my district, the one thing that I continually try to bring things down to—and I think that Mr. Sklar started out his presentation in a very effective manner by doing the same—is to get an understanding with the people that I'm speaking with that we are in difficult economic times, that we have tight budget constraints, that we don't have a lot of money to put into programs unless—and I put an important emphasis on the unless—unless we can justify the expenditure of that money. It is my perception that the energy business is an untapped potential that has the ability of increasing our investment over time, whereas many of the programs that Government in general tries to incorporate often times shows that we end up having to expend more money in the long term than realizing any kind of a profit.

Profit, obviously, doesn't only mean a monetary profit, it means that it has to be of social value, a value to our environment, and, I think also equally important, a value to the Nation's security. To take that approach I think is the most responsible approach. And as I discuss with you this morning a few of the points that you made, I hope that you, if not able to do it this morning, can get back to me with representations of the requirements, the funding that you've asked for, and the circumstances within your industry that would give me the kind of information I need in order to demonstrate to my constituents and to those who I will hopefully be leading that this is a wise investment and that this is going to produce jobs, it is going to increase the quality of life, that it is going to be realized as an expansion of our industrial marketplace, whether it is because we are producing more wind turbines, photovoltaic cells, waste energy facilities, or that there are other ramifications because we make our industries more competitive because they are leaner and meaner and are able to utilize every BTU available to them at its maximum efficiency.

And so these are the kinds of things that I hope that you in addressing the questions I have and in the discussions I am sure we will have over the months and hopefully years to come, that we'll be able to address these problems in this manner and therefore be able to demonstrate to the American public that this is not an irresponsible approach and that this is actually probably the most responsible of all approaches.

To begin, I wanted to comment and get your comments, more particularly, on the utilization of small source generation at the residential level, the small community level. I think it has a tremendous impact on a number of aspects—and don't worry, Ken, I'll get to the 80 megawatts; I have a question for that, too. But as it pertains to the small source, one of the things that I have come to understand is that we have a woefully inefficient infrastructure not only in highways and bridges, but our transmission lines have tremendous line droppages over considerable distance.

I see that our first ability to tap efficiency is to begin a more comprehensive production of small source energy production that would put the generation right next to the use and therefore reduce that kind of loss through line loss. This pertains particularly to my district, which is a fairly large and rural district where most generation takes place within the southern part of the district and the northern part of the district is not realizing that efficient energy because of the antiquated lines.

How is this kind of approach, and I am talking about at a residence. I mean, take my example as the example here. How is someone who is looking at buying a home and implementing this technology able to access the production of energy at that kind of a scale, vis a vis the cost of electricity and the availability of technology and the common sense understanding that most people would hold in the average citizenry as it pertains to putting this kind of technology into the household?

Mr. **Sklar**. Well, I would like to start off by saying that in December, 26 of the world's utilities met, hosted by the CEO of ENEL, the largest utility in Europe, to look at how to deal with photovoltaics in terms of rapidly commercializing it. It was an interesting conference we had. It was really a think tank meeting of senior end-users in the utilities sector from Tokyo Electric to PG&E. They looked at two major diffusion models for our technology. One is line voltage augmentation, that both PV and wind are ideally suited for, which usually is used by the utility itself to keep power in its line and stop the voltage droppages or islanding that occurs from those droppages. And they see that as a 15,000 megawatt market in the United States and about a 60,000 megawatt market worldwide. That's an immense market potential if we can tap it. And one of the things that we are going to DOE on and coming to the Congress on is can you help us with the Federal Power Marketing Administrations that are the biggest distributors of power, to help us get this technology that way.

The second diffusion model was rooftop systems on housing. Sanyo has come out with a photovoltaic roofing shingle. Some of the glass companies in Japan are looking at photovoltaic films on glass which also have insulating see-through films on glass, and even have electrochromics that darken or lighten the glass for both energy and lifestyle use. And they believe that that is a multi-multi-billion market in the glass side.

The fact of the matter is we have in the photovoltaics budget this year money to start getting photovoltaic laminates in residential buildings and test them to see how they interact with the grid. We have some companies particularly around the United States that operate in areas where they have time-of-day electric metering. Thirty-seven cities have twenty-five cent per kilowatt hour and higher costs. When you tie photovoltaic systems with energy efficient lighting, low voltage lighting, high reflective, it is very cost-effective. And we have some companies working with homeowners and commercial end-users to get PV there.

Lastly, 17 percent of building energy use is water heating. Solar water heating, again, we have 1.2 million buildings in the United States with it, which is a lot in 15 years. The city of Tokyo alone has the same amount in 6 years. And we've got to get our act together. It is not that we do not have technological problems anymore. And that's what I really want the committee to understand. The technological problems are really there. What we need to do is how to leverage it into the private marketplace because the technological refinements can only happen in the real world, not in the laboratory.

Mr. **Swett**. Okay. Well, there is a demonstration project awaiting your participation in Borough, New Hampshire.

Dr. Klass, I understand that you are very involved in co-generation and I was wondering if you could give some comment as to that technology at the same scale that we're discussing—at the residential, small producer scale.

Dr. **Klass**. At the residential level, Mr. Swett, I am not too certain as to what the future holds for co-gen systems that small. But I think overall all of the technologies we're talking about, when lumped together, and this includes PV, solar thermal, solar hot water heating, and a few applications of biofuels at the residential level, I think would offer quite a number of opportunities. The most important one, I couldn't tell you whether it is co-generation or not. I have a feeling that based on where we stand today with technology, we have to be at least 25 to 50 megawatts and higher unless we're talking about the ultra-small biomass gasification type systems, which I have seen as small as 25 kw. They do offer a few co-gen applications, but I don't think for a household the technology has been developed to that point yet.

Mr. **Swett**. I am currently very interested in any kind of conservation legislation that is in the hopper. It has been interesting to me to find that there is very little interest in Congress nor is there very little energy—and I use that not as a pun—to push this legislation through as it relates to encouraging conservation and then utilizing those savings to act as the profit motive for the private sector investment, and then taking the other savings which are left over on the Government side, if we can assume that the Government would take a leading role in this, and plowing that back into a conservation tax credit or incentive of some sort, if you will, that will encourage sort of the snowball to continue rolling down the hill.

This is an area that I find very, very frustrating and certainly you can see by the vast array of colleagues that my good Chairman and I have displayed around us that it isn't yet at its zenith of importance. But I think that for the most part having these discussions really are very important. And I commend you your time and your research and your commitment to performing not only before us here today but, more importantly, as you work in your labs and try and talk within the public at large as we try to encourage people to use more and more of these kinds of technologies.

Mr. **Scheuer**. The time of the gentleman has expired.

Mr. **Swett**. If I may make one concluding remark.

Mr. **Scheuer**. You may.

Mr. **Swett**. I appreciate that Mr. Chairman. I wanted to get back to Kent and say that I agree that there are arbitrary limits placed on generation from facilities of the size that you mention. And that I would like your comments on the technology of possibly incorporating an approach that would allow not only these limits to be removed but that would encourage facilities of the size that you talk about to incorporate a more, if you will, holistic approach to production of power, reduction of waste, recycling of material, and use of waste heat, which in concert would entitle any facilities of this nature to increase their ability to maximize that cap. And I will only close by saying that I feel that this is certainly a very possible approach not only because of the benefits of the technology, but it is my understanding that we in this country, because of the high capital costs for producing such facilities, not only need to maximize every BTU that they generate but I am finding that utilities in general are—and I will be quick; I appreciate that, Mr. Chairman—that utilities themselves are less inclined to make the capital expenditures and are moving more into the holding business of electric distribution.

Mr. **Burton**. I will be quick too, Mr. Chairman. With respect to the holistic approach, if I understand you correctly, Mr. Swett, to integrated waste management, whenever a community decides to invest in one of these facilities, increasingly the trend is to take the integrated approach to solving their waste problem. It is very unusual that they will decide exclusively on the waste energy option. Ordinarily, facilities are cited with a fair margin for recycling and, indeed, in conjunction, increasingly to some sort of MURF capability. Specific examples could be cited. That integrated approach is clearly the answer to the problem. To the extent regional facilities are called upon though in larger waste shed areas, the cap continues to be frustrating to the industry and, again, it is something that we would like to see removed in time.

Mr. **Swett**. With great appreciation for the work that you are providing, Mr. Chairman, I yield back to the Chairmanship.

Mr. **Scheuer**. Thank you very much. Time has really run out for us but I am going to go a little bit over time, with your indulgence.

Let me ask all of you—and I would like to hear especially from Mr. Swisher and Mr. Perry, whom we haven't heard from in the question period, and then go to the rest—we have a real problem in this country as to creating a market for energy efficiency programs and energy conservation programs while our country is awash in cheap oil, as we have been for decades, while our Congress and the

Executive Branch tax oil and gasoline at approximately one-tenth of the rate at which our colleagues in the developed countries around the world tax their people. The average price for gas in the developed world is somewhere around $4 or $4.50 a gallon. In our country, when it hits $1.50 a gallon people are in paroxysms of anguish and horror.

When energy is that cheap it reduces the financial viability or attractiveness of energy conservation programs and energy efficiency programs. For example, take the automobile industry as an obvious example. Our competitors abroad in the developed world, at least four of them—Japan, Germany, Holland, and France—produce cars that go 80 miles per gallon in the city and 100 miles per gallon in the country. Japan has one that goes about 120 miles a gallon in the country. Now that technology costs money. Perhaps it would raise the price of a car $1,000 or $1,500. If you are paying $75 or $80 a tank for gas, as I did in Italy last summer for a little tiny car, it concentrates your mind on fuel economy and fuel efficiency.

The automobile companies say, and rightly so, it doesn't pay us to go into that area of developing new technology. We're trying to get up to the 40 or 50 miles per gallon area that we can do with existing technology. But nobody would pay that much more for a car that went beyond that while gas is so cheap. And I think all of you can tell in your own areas. Mr. Sklar, you were complaining that the State regulatory agencies will not permit you to pay more for wind energy than their cost avoided. Right? Energy cost avoided. Well, it doesn't do the trick; it doesn't create a market incentive.

What do we have to do at a time when this country is awash in cheap energy to create market incentives in the entire field of renewables and in not only energy efficiency but energy conservation? What do we do to create incentives for industry to move in when we are awash in $1.50 per gasoline?

Mr. Swisher, and then Mr. Perry, and then the rest of you.

Mr. **Swisher**. Mr. Chairman, I think we have to be sending the right kinds of signals to the financial markets. Right now, there are at least half a dozen companies with very strong engineering talent that are working on design of advanced wind turbine technology. Those companies are not going to be able to get adequate capital to bring those designs to fruition unless there is a clear signal that this country has made a commitment to moving forward with renewable technologies rapidly. And the best way to send that signal would be for the U.S. Congress to pass a long-term set of financial incentives for wind and other renewable technologies, similar to the proposal that was in the draft National Energy Strategy. I think it is as simple as that. And making the kinds of regulatory changes at the State level that will make financable contracts for wind and other renewable technologies possible on a widespread basis. If we take those two steps, you are going to see a virtual boom in the renewable technologies that are cost competitive today.

Mr. **Scheuer**. Thank you.

Mr. Perry?

Mr. PERRY. I happen to be a president of a firm in Belgium called Hydrogen Systems. We have recently demonstrated a bus, which we call Green Bus, and a small people mover, called the Eurocar, to run on hydrogen. Now we happen to be competitive in Europe right now with this hydrogen. And the best thing you could do here was to put some money on the hydrogen and we will have it licked here both as to not depending on foreign oil and we'll have a clean atmosphere.

Mr. SCHEUER. What do you mean by putting some money on the hydrogen?

Mr. PERRY. Well, in my talk I said that we would practically split the cost of building the Green Car. So we are asking in the budget that you put money on that race, so to speak, and we'll lick it.

Mr. SKLAR. My view from the big picture is that what the Congress needs to do is put a series of user fees on energy to pay for other problems that come from these sources of energy. And it is not just environmental problems, but it is property loss, environmental remediation, security of supply. Frankly, if there were those kinds of user fees that would go to that, it would—frankly, when the consumer had to pay more and either the commercial or residential would have to pay more for that technology because of the result of those user fees, they would naturally come towards the renewables.

And the second thing, and Randy Swisher is right, is that the Government also has to have some kinds of both production investment incentives and also some capitalization. You can capitalize solar and renewables out of the State and local programs, out of DOE. And you can capitalize renewables out of some existing Federal agency programs.

Dr. KLASS. Mr. Chairman, I would like to make a few remarks on your remarks actually regarding your Italian experience. Because you had to pay that much for gasoline and because the price of crude was the driving force over there behind the price of gasoline, they have the largest biofuels energy plantation in the world in operation. So, in my mind, the price of crude is the driving force behind the momentum that can be developed I think for renewables in all of its aspects.

Now, you can talk about tax incentives. You can talk about user fees. There are many, many approaches to this. I don't know what the best one is, but we have to face the price of fossil fuel every step of the way and that is what is going to be the driving force behind commercialization of renewable energy, all the different ones we talked about, unless, on their own, the price can be reduced to the point where it is ridiculous to stay out of it as an economic entity. For example, the cost of PV on rooftops. To me, that's the ultimate. If we could get that cost down to the point—now I am not a PV expert by any means at all, but I can still see rooftop units on my home. With the utility lines cut, it has nothing to do with the price of oil. That is the only way to get this going.

If we are going to be talking about tax incentives all the time, I think we are almost lost at the beginning. A good example of where an incentive—a tax subsidy or tax forgiveness, whatever you choose to call it, I call it a tax forgiveness—is the subsidy for ethanol fuel made from Midwestern corn. If that tax forgiveness legislation did not exist on the Federal level, I think there would be no ethanol fuel business. I have heard many people in this business tell me that. I can't say that is an absolute certainty, but it is very close to a truism. Now I don't think we can afford to have these kinds of subsidies and tax forgiveness legislative activities provided for all the renewables. I think we are going to be faced with the technology standing on its own in the long-term and competing with the price of oil, whatever it may be.

Mr. **Scheuer**. If we are going to have to let these technologies compete on their own with $1.50 gasoline, it could be a long, long time before legitimate incentives would be there to attract the kind of capital and the price of capital that would be necessary to really change the equation and make it attractive to move toward energy efficiency and energy conservation.

Dr. **Klass**. Mr. Chairman, if we get up to $1.50 a gallon on gasoline in this country, there will be an abundance of renewable technologies that will be competitive.

Mr. **Scheuer**. We're up to it. We're at $1.50 a gallon now.

Dr. **Klass**. Well, not in our territory, which is the Midwest.

Mr. **Sklar**. But I would like to point out too that our markets are expanding in renewables. We are competing, as is, right now. The reason we're doing so is mostly environmental regulation at the local level. When Southern Cal Edison needs extra electric capacity and they can get one of these solar steam plants up in less than a year, their view is they don't care if it was, you know, burning chipmunks, whatever it is to take to get electricity during that year, they will do it. And I think if we force the private sector, the end-users to have to do certain onerous things, they will come to our technology naturally, as they are right now, or we wouldn't be here sitting before you.

Mr. **Scheuer**. So you think this movement toward alternative fuels and fuel economy, in general, for both stationary energy users and vehicles can come from our gradually heightened standards of what is environmentally acceptable?

Mr. **Sklar**. Both environmental and security. I think what many of us on this panel are coming to you is that if there is a way we can incorporate some of the assurance of having a levelized cost of energy, albeit a little higher maybe right now but sure that that energy will be there forever at a real predictable cost, that's worth a lot to the U.S. economy.

Mr. **Burton**. Mr. Chairman, if I may just supplement a little bit.

Mr. **Scheuer**. Please.

Mr. **Burton**. I think in the sentiment of what has been said here, as requirements are identified to put new power on line, as local utilities or PUCs are required to identify externalities associated with putting on-line different forms of power and characterizing those externalities in terms of environmental degradation, which is the case in terms of fossil fuels, or positive externalities, I would suggest in association with waste energy facilities, the positive externality being the combustion of waste and removing of a social problem; namely, solving a solid waste management crisis—as those are characterized and those requirements are made to characterize those externalities, positive/negative, then I think indeed you will see an increased movement in favor of the renewable technologies we're talking about.

The hierarchy should be when power requirements are identified. The first requirement ought to be consideration of renewable resources in whatever form, and movement towards consideration would follow as a result of requirements to consider externalities, positive or negative, in solving social problems or characterizing environmental degradation. That will help the combined renewable energy move ahead.

Mr. **Scheuer**. Well, this has been a remarkably interesting panel. I thank all of you for your patience and tolerance. It is now exactly 11:30 [sic] and you have all been here a long time. The sun is now past the yardarm. And I thank you all for your contribution.

The hearing is adjourned at the call of the Chair.

[Whereupon, at 12:30 p.m., the hearing adjourned, to reconvene at the call of the Chair.]

FISCAL YEAR 1992 AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S ENERGY CONSERVATION PROGRAM

WEDNESDAY, APRIL 17, 1991

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Environment,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:07 p.m., in room 2318, Rayburn House Office Building, Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. Scheuer. The Subcommittee on Environment of the Science, Space, and Technology Committee will come to order.

Will the witnesses in the room for the first panel please take their seats at the panel? Howard Geller, Charles Guinn, Art Rosenfeld, Marc Ross, and Eric Hirst.

Okay. Is Howard Geller in the room? He's here but not in the room. Okay.

All right. I'm sure that Mr. Geller will be with us shortly. In the meantime—why don't we get started with Mr. Geller. How are you, Mr. Geller?

All right. Today, the Subcommittee will consider the Department of Energy's request for its energy conservation program. The funding proposal submitted by the Department calls for an increase of 27 percent over fiscal year 1991 budget levels. This, of course, is a significant increase, but in all candor, I must tell you that even after the increase it remains two-thirds below the level of support this program received in fiscal year 1979 in real dollars.

Department of Energy's conservation program was one of the great successes to come from President Carter's energy program. The energy efficiency developments and programs that were put into place in the late 1970s were responsible for reducing by about 30 percent the growth trend in energy consumption. These measures were instituted at a time when the price of imported oil had increased roughly 250 percent, by two and a half times. Once oil prices evened out in the mid 1980s, there was far less incentive to invest in renewable energy sources and energy conservation programs.

The real lack of Federal stewardship and leadership over the program in the 1980s significantly compromised development of new energy conservation technologies. The Reagan Administration, for example, zeroed out funding for the transportation, industrial and buildings, and community systems programs for fiscal year 1983 based on the mistaken assumption that sufficient market incentives existed to assure that the private sector would make efficiency improvements if such a strategy were warranted by the market.

Absent that clear direction from the Federal Government concerning the importance of energy efficiency to our national security and competitiveness, this program floundered and in 1989, as a consequence, the U.S. recorded an all time high of energy consumption.

In the last Congress, this Committee developed the conservation and renewable energy bill of 1989. The Committee strongly supported increased the R&D commitment for energy—for conservation programs ever since then.

We did this for a number of reasons. First, the increased efficiency reduces energy demand and energy consumption and thereby lessens our dependence on imported energy sources—imported fossil fuel energy. Second, energy efficiency addresses important environmental concerns, namely the reduction of greenhouse gases associated with the burning of fossil fuels. And, third, improved energy efficiency can improve our competitiveness by reducing production costs and by increasing productivity and by creating new markets for U.S. products.

Many utilities are currently implementing major energy conservation programs based on the assumption that the cheapest kilowatt hour they can acquire is one that they are already generating. This is called the so-called least cost planning on the assumption that if you have an energy shortage it may be cheaper to solve that shortage by reduced demand than it is by increased supply.

My own State of New York and the State of California are in the Vanguard of States that are working very constructively and creatively with their State utility commissions to implement least cost planning strategies.

The energy savings that utilities can realize can be used to offset increased demands for energy production and thus obviate the need to bring more energy generating facilities on line. This is what least cost planning is all about.

I'm concerned that while the Federal Government's facilities consume 1.9 quads, or roughly 2.4 or 2.5 percent of the energy generated nationwide, we have not embarked upon a more rigorous energy conservation program even in the buildings that the Federal Government owns and controls. This is lugubrious. For several years, the DOE has said that it is working on an Executive Order concerning the usage of energy in Federal buildings. I am almost attempted to say, "Where's the beef?" Where is this Executive Order. I hope we will hear much more about it during the course of this hearing today.

The buying of the Federal Government shouldn't be underestimated when it comes to leveraging the market for energy technologies from efficient light bulbs to smart buildings to efficient heating and cooling systems. An assured market for these developments will serve to increase domestic production of some of these technologies and ultimately reduce the cost.

Also not to be ignored is the role of the Federal Government as role model. The role of the Federal Government and the Executive Branch in the bully pulpit, wagging their finger and showing us the way to go, grabbing our attention. What's wrong with some Federal leadership addressed to the business of making Federal buildings more energy efficient, giving us a bigger bank for a buck and acting as an example of what the private sector could do? For goodness sake, that role is so obvious it defies further description.

I look forward to hearing from the distinguished witnesses here today. As all of you are aware, this area of alternative energy and energy efficiency and energy conservation constitute a new area of jurisdiction for this Subcommittee. We are very excited about it, and we look forward to working with each and every one of you to help chart a more constructive and more productive future course for the Federal Government in the upcoming fiscal year and as we develop our legislative contribution to the National Energy Strategy Initiative.

I would now like to recognize the ranking Republican member of this Committee present this morning, Congresswoman Connie Morella.

Mrs. **MORELLA**. You had to listen closely to that to get the nuances.

Thank you, Mr. Chairman.

Mr. **SCHEUER**. Always listen closely to the nuances.

Mrs. **MORELLA**. That's absolutely right, particularly when you hear words like lugubrious. [Laughter.]

Energy conservation, Mr. Chairman, is important for all the right reasons. It fights air pollution, acid rain, global warming. The National Academy of Sciences stated on April 10th that the U.S. could reduce by 40 percent its emissions of industrial gases if we moved quickly to use current technologies. In light of this recent report, we hold a hearing on the Administration's fiscal year 1992 budget request for the Department of Energy's Energy Conservation Program. We are considering how energy conservation measures can offset growing demands for energy, and examining energy conservation measures in the National Energy Strategy.

Happily, the 101st Congress adopted legislation to improve energy conservation. There was an increase of 16 percent in R&D funding for Fiscal Year 1991. The State Energy Conservation Programs Improvement Act updated energy efficiency goals and gave greater flexibility to State programs. The Clean Air Act Amendments encourage conservation measures by offering sulfur dioxide emission offsets.

I know we are going to be hearing about the adequacy of funding for energy conservation R&D. The proposed level for Fiscal Year 1992 is higher than 1991, and I would hope that the funding will continue to increase. The time has come to give adequate funding for energy conservation R&D to be internationally competitive, to improve air quality, and slow global warming.

I look forward, Mr. Chairman, to hearing from our witnesses about the Federal role in conservation implementation. What is the proper blend of command and control measures and the market-driven approach to encourage greater energy efficiency and conservation? Those are some of the questions that will be responded to.

Energy conservation is one of the major challenges of the 1990s. I thank our witnesses today for assisting us in reviewing our options for change. And Mr. Chairman, I agree with you. I am excited that it comes under the jurisdiction of this Subcommittee.

I yield back the balance of my time.

[The prepared statement of Mrs. Morella follows:]

AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S ENERGY CONSERVATION PROGRAM

CONGRESSWOMAN CONNIE MORELLA
APRIL 17, 1991

Constance Morella

MR. CHAIRMAN, ENERGY CONSERVATION IS IMPORTANT FOR ALL THE RIGHT REASONS. IT FIGHTS AIR POLLUTION, ACID RAIN, AND GLOBAL WARMING. THE NATIONAL ACADEMY OF SCIENCES STATED ON APRIL 10 THAT THE U.S. COULD REDUCE BY 40 PERCENT ITS EMISSIONS OF INDUSTRIAL GASES IF WE MOVED QUICKLY TO USE CURRENT TECHNOLOGIES. IN LIGHT OF THIS RECENT REPORT, WE HOLD A HEARING ON THE ADMINISTRATION'S FISCAL YEAR 1992 BUDGET REQUEST FOR THE DEPARTMENT OF ENERGY'S ENERGY CONSERVATION PROGRAM. WE ARE CONSIDERING HOW ENERGY CONSERVATION MEASURES CAN OFFSET GROWING DEMANDS FOR ENERGY, AND EXAMINING ENERGY CONSERVATION MEASURES IN THE NATIONAL ENERGY STRATEGY.

HAPPILY, THE 101ST CONGRESS ADOPTED LEGISLATION TO IMPROVE ENERGY CONSERVATION. THERE WAS AN INCREASE OF 16 PERCENT IN R&D FUNDING FOR FISCAL YEAR 1991. THE STATE ENERGY CONSERVATION PROGRAMS IMPROVEMENT ACT UPDATED ENERGY EFFICIENCY GOALS AND GAVE GREATER FLEXIBILITY TO STATE PROGRAMS. THE CLEAN AIR ACT AMENDMENTS ENCOURAGE CONSERVATION MEASURES BY OFFERING SULFUR DIOXIDE (SO2) EMISSION OFFSETS.

I KNOW WE WILL BE HEARING ABOUT THE ADEQUACY OF FUNDING FOR ENERGY CONSERVATION R&D. THE PROPOSED LEVEL FOR FY 92 IS HIGHER THAN 1991, AND I WOULD HOPE THAT THE FUNDING WILL CONTINUE TO INCREASE. THE TIME HAS COME TO GIVE ADEQUATE FUNDING FOR ENERGY CONSERVATION R&D

- TO BE INTERNATIONALLY COMPETITIVE, TO IMPROVE AIR QUALITY, AND TO SLOW GLOBAL WARMING.

I LOOK FORWARD TO HEARING FROM OUR WITNESSES ABOUT THE FEDERAL ROLE IN CONSERVATION IMPLEMENTATION. WHAT IS THE PROPER BLEND OF "COMMAND AND CONTROL" MEASURES AND THE "MARKET-DRIVEN" APPROACH TO ENCOURAGE GREATER ENERGY EFFICIENCY AND CONSERVATION?

ENERGY CONSERVATION IS ONE OF THE MAJOR CHALLENGES OF THE NINETIES. I THANK OUR WITNESSES TODAY FOR ASSISTING US IN REVIEWING OUR OPTIONS FOR CHANGE.

Mr. SCHEUER. Thank you, Congresswoman Morella.

Congressman Dick Swett of New Hampshire?

Mr. SWETT. Thank you very much, Mr. Chairman.

I'm pleased to see the way you are taking the bull by the horns with this Subcommittee's new energy jurisdiction and making sure that this issue gets the attention it needs. I believe it is vital to our national interest.

Mr. SCHEUER. May I just intervene for a moment?

Mr. SWETT. Yes.

Mr. SCHEUER. Dick Swett had a long and distinguished professional career in the field of energy conservation. He has a great potential contribution to make to the work of this Committee in this new area of jurisdiction. I'm delighted you're working with us, Dick.

Mr. SWETT. Thank you very much, Mr. Chairman.

I believe it is vital to our national interest to develop safe, clean domestically available sources of energy while also cutting down on our energy requirements. I am pleased to see, Mr. Chairman, that you are taking the lead on this issue as well.

I am truly committed to improving our Nation's energy efficiency, as the Chairman indicated by my professional background. It is not only due to my own professional background that I feel this way. I have five children whom I love very much and I don't want to leave them a world where they can't breathe the air or they can't drink the water. I don't want them to live in constant fear of foreign powers that control our energy supply holding our Nation hostage to their demands.

I want to commend this Administration for the increased importance they have placed on energy conservation. I want to particularly commend the leaders at the Department of Energy who are creatively and successfully moving our Nation toward better energy conservation.

But there is still much to be done. I hope that through this hearing our distinguished witnesses will address themselves to several issues. How can we cut down on the Federal Government's phenomenal use of energy? How can we make better use of energy in industry, which would also make our industries more competitive? How can we level out the peaks and the valleys of energy production our electric utilities must bear, which would make them also more efficient? But most importantly, I would like to hear your opinions on the greater issues we face. How can we get private industry, State and local governments to work together to conserve energy in a better fashion? And how can we create broader interest in energy conservation among the public at large, since it is only by creating such interest that we will truly change the way we consume energy?

Unfortunately, the other Committee that I am a member of is also holding an important hearing that I have to attend. So please don't interpret my comings and goings as disinterest. I have all your statements. I will read them carefully.

In closing, I just add one more comment, and that is that as I walk down the halls of these buildings of Government and look up, I see in many instances where fluorescent light bulbs could be used, incandescent bulbs still in use. I would hope that by the end of my term—my first term in Congress—we could make that switch and somehow start realizing the conservation efforts that this whole country needs to see, especially through the example of the Government.

Mr. Chairman, I thank you for this time. I yield back what remains of it.

Mr. **SCHEUER**. I thank you. Nothing remains of it, and we're delighted to have had your contribution.

Congressman Howard Wolpe from the State of Michigan?

Mr. **WOLPE**. Thank you very much, Mr. Chairman.

I do not have any opening statement. I look forward to hearing the testimony of our witnesses this morning.

Thank you.

Mr. **SCHEUER**. I thank you, Congressman Wolpe.

We'll start—age before beauty I suppose—so we'll start with the youngest member of the panel, I would think, a very distinguished member of the energy community, Howard Geller.

May I say to all of you that your statements will be printed in full at this point in the record. Because we have two panels—three panels—we have a dozen witnesses this morning, so we're going to have to ration our time very jealously. So we're going to stick to the 5-minute rule. That is going to apply to Members of Congress on this side of the bench as well as to the folks at the witness table. So pardon us for being rude, but we are going to engage in a strict rationing program, 5 minutes to one and all.

Please proceed, Mr. Geller.

STATEMENT OF HOWARD S. GELLER, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY, WASHINGTON, DC

Mr. **GELLER**. Thank you, Mr. Chairman and members of the Subcommittee. I am testifying on behalf of the American Council for an Energy Efficient Economy, a non-profit organization that analyzes and promotes energy conserving technologies and policies.

First of all, we would like to inform the Subcommittee that we are extremely pleased to the see the Bush Administration request a significant increase in the energy conservation R&D budget for fiscal year 1992. For years we have seen the Administration request counterproductive drastic budget cuts in this area. It is a relief to see the Bush Administration acknowledge the need to expand energy efficiency R&D. We have reviewed their budget request and in general we support the specific increases the Administration has requested.

Although the Administration is moving in the right direction, we believe their R&D budget request is inadequate in many areas. After the nearly two-thirds cut in the program in the early and mid 1980s, there are many worthwhile projects that are unfunded or under-funded. Even with the proposed increases in the conversation R&D program, the priorities within DOE's overall energy R&D program are still extremely unbalanced in our opinion. Conservation is targeted to receive only 8 percent of the total energy R&D funds, according to the Administration's request.

The Administration is requesting a $59 million increase for conversation R&D, compared to a $156 million increase for nuclear fission and fusion R&D. Given its track record and contribution to our Nation's energy service needs, as well as the potential for further efficiency improvements, conservation R&D should receive a much larger slice of the total energy R&D pie.

Our views regarding the need for even greater increases in conservation R&D are consistent with DOE's own views. We have learned that DOE staff initially requested $309 million for conservation R&D in fiscal year 1992, a 44 percent increase over the fiscal year 1991 appropriation, but the Office of Management and Budget cut back the request to $274 million. OMB also heavily cut DOE's original request for technical and financial assistance programs related energy conservation.

Because of the relative low priority still being given to conservation R&D by the Administration, a coalition of environmental, consumer, business, and State government organizations once again has developed an alternative energy conservation budget. The alternative budget is based on input about what can and should be done to accelerate the development of energy efficient technologies and to improve our Nation's energy efficiency from conservation experts around the country.

I'm providing the final version of the alternative budget to the Subcommittee today and ask that it be included in the hearing record. This is the first time that it has been presented in public.

Using the Administration's request as a starting point, the alternative budget recommends increases for existing research programs as well as important new initiatives. It pertains to R&D as well as the technical and financial assistance components of the energy conservation program.

Table 1 in my testimony summarizes the budget request, although between when I produced the testimony and completing the alternative budget we made some slight changes. I would like to suggest that the Subcommittee use the numbers in the actual alternative budget as a point of reference and not those in the table in my testimony.

Overall we are recommending a conservation R&D budget of $365 million, 32 percent above DOE's request and about 67 percent above the current funding level. We are urging increases of about 85 percent in the building sector, 14 percent in the transportation sector, 12 percent in the industrial sector, about 200 percent in utilities relative to the DOE request.

The building sector is an area where DOE is really lacking enough funds to really conduct a thorough effort where the private sector, with its great diversity and small—relatively small companies constructing buildings—the private sector is doing very little R&D on its own.

The utility sector is a new sector under DOE's current organization scheme. It needs much more fun ding than the small $7 million that DOE is requesting.

Assuming the total budget for R&D remains at the level requested by DOE, our overall recommendation is to allocate 13 percent of the total, not 8 percent of the total, to energy efficiency R&D. We believe the fraction is still modest given that energy efficiency improvements are so critical to the economic competitiveness, security, and environmental integrity of our Nation.

Given that many projects are still unfunded or underfunded, we believe that the fraction of energy R&D devoted to efficiency should rise steadily over a number of years. We hope that this Subcommittee will come forward with a multi-year authorization bill that will recognize the role that efficiency is playing and can continue to play and that we will see substantial increases over time in that effort.

I will skip the examples in my testimony and leave that for the written statement. Also, I think the subsequent witnesses will get into some specifics of where we need increases.

Let me stop and take questions and let us continue.

[The prepared statement of Mr. Geller follows:]

TESTIMONY TO THE

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE, AND ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ON DOE'S ENERGY CONSERVATION RESEARCH AND DEVELOPMENT PROGRAM

HOWARD S. GELLER

EXECUTIVE DIRECTOR
AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY
WASHINGTON, DC

April 17, 1991

Mr. Chairman and members of the Subcommittee, I am testifying on behalf of the American Council for and Energy-Efficient Economy, a non-profit organization that analyzes and promotes energy conserving technologies and policies. The Council was formed in 1980 by some of our nation's leading energy efficiency experts. We have been evaluating DOE's conservation R&D program and advising the Congress on this subject since 1986.

First, we would like to inform the subcommittee that ACE^3 is extremely pleased to see the Bush Administration request a significant increase in the energy conservation R&D budget for FY92. For years we have seen the Administration request counterproductive budget cuts in this area. It is a relief to see the Bush Administration acknowledge the need to expand energy efficiency R&D. We have reviewed their budget request and in general we support the specific increases the Administration has requested.

Although the Administration is moving in the right direction, we believe their energy conservation R&D budget request is inadequate in certain areas. After the approximate two-thirds cut in the conservation R&D program in the early and mid-1980s, there are many worthwhile projects that are unfunded or underfunded. Even with the proposed increases for the conservation R&D program, the priorities within DOE's overall energy R&D program are still extremely unbalanced in our opinion. Conservation is targeted to receive only 8% of total energy R&D funds according to the Administration's FY92 budget request. The Administration is requesting a $59 million increase for conservation R&D, compared to a $156 million increase for nuclear fission and fusion R&D. Given its track record and contribution to our nation's energy service needs as well as the potential for further efficiency improvements, conservation R&D should receive a much larger slice of the total energy R&D pie.

Our views regarding the need for even greater increases in the conservation R&D budget are consistent with DOE's own views. We have learned that DOE staff initially requested about $309 million for conservation R&D in FY92, a 44% increase over the FY91 appropriation. But the Office of Management and Budget cut this request back to $274 million, a $35 million net reduction compared to DOE's request. OMB also cut DOE's original request for technical and financial assistance programs related to energy conservation.

Because of the relatively low priority still being given to conservation R&D by the Administration, a coalition of environmental, consumer, business, and state government organizations once again has developed an alternative energy conservation budget. The alternative budget is based on input about what can and should be done to accelerate the development of energy-efficient technologies and to improve our nation's energy efficiency from conservation experts around the country. The final version of the alternative budget will be provided to the Subcommittee very shortly. I am presenting a summary of the alternative budget for the first time in public today.

Using the Administration's FY92 request as a starting point, the alternative budget recommends increases for existing research programs as well as important new initiatives. The alternative budget pertains to technical and financial assistance programs as well as R&D. Table 1 summarizes how the alternative budget compares with DOE's request for FY92 as well as this year's appropriation. Overall, we are recommending a conservation R&D budget of $352 million, 29% above DOE's request and 64% above the 1991 funding level. Compared to DOE's request, we urge increases of 70% in the buildings sector, 14% in the transportation sector, 10% in the industrial sector, and 213% in the utilites sector. The buildings sector is one area where DOE is lacking enough funds to conduct a thorough energy efficiency R&D program and where the private sector performs very little R&D on its own. The utility sector is a new program area under DOE's current organization structure, and it needs much more funding than the small amount ($6.8 million) DOE has requested.

Assuming the total budget for energy R&D remains at the level requested by DOE, our overall recommendation is to allocate 13% (rather than the 8% proposed by DOE) to energy efficiency R&D in FY92. We believe this fraction is still modest given that energy efficiency improvements are critical to the economic competitiveness, national security, and environmental quality of our nation. Given that DOE's R&D program makes an important contribution to the development and dissemenination of energy-saving techniques and that many projects are now unfunded or underfunded, we believe that the fraction of energy R&D devoted to efficiency should rise steadily over the next few years. I would like to add that the Budget Committee recently recommended a substantial increase in the energy conservation program in its budget resolution.

Compared to DOE's request, we are recommending more than a 700% increase in technical and financial assistance efforts because DOE has proposed cutting federal funding for these efforts by 82%. Our recommendation is for a 47% increase in technical and financial assistance programs relative to FY91 funding. These efforts are especially important for increasing the efficiency of housing occupied by low-income households. The Administration's arguement that federal funding is unnecessary because of oil overcharge funds being available is incorrect and irresponsible, in our opinion. Many states will end up reducing their conservation efforts in low-income housing and public buildings if the Administration's budget is accepted. The Congress has wisely rejected the Administration's proposed cuts in state assistance programs in the past, and we urge you to do so once again.

In the remainder of my testimony, I present some examples of new initiatives or critical increases to existing programs suggested in the alternative budget. The other witnesses will elaborate on the gaps in DOE's program and what should be done about it.

Windows and Daylighting Research

One area in need of additional support is the windows and daylighting research program. This program has developed new window technologies such as low-emissivity glass coating in the past and it has the strong support and cooperation of the fenestration industry. DOE has proposed cutting these programs from $4.1 million in FY91 to $3.5 million in FY92. We suggest adding $3.0 million to DOE's request. Additional funding is needed for development and testing of innovative glazings, so-called "superwindows" that have very high R-value, and also to provide technical support for the national effort to develop and adopt energy ratings and labels for windows. The National Fenestration Rating Council, a public-private joint effort, has developed interim guidelines for testing the efficiency of windows. More work is needed to refine the test procedure and promote it.

Appliance and Lighting Standards

The Administration is requesting $2.5 million for appliance and lighting standards analysis in FY92, up from about $2.0 million in FY91. However, this not enough funding considering that DOE is required by law to complete rulemakings on nine different products by the end of 1992. Also, a proposed rule on three additional major products (furnaces, central air conditioners, and heat pumps) is due out in FY92. Work on appliance and lighting standards is extremely important since it is required by law, it directly results in energy savings, and the regulations affect major consumer products and manufacturers. DOE should have enough money to due a thorough job and get the rulemakings done on time, something not now occuring due in part to lack of funds. We recommend increasing total funding for this activity to $4.0 million in FY92.

Advanced Insulation Development

Development of new high thermal resistance insulation materials that do not contain CFCs (i.e., to substitute for polyurethane foam) is critical given the need to both conserve energy and protect the ozone layer. A variety of vacuum insulation concepts look extremely promising for achieving this goal. DOE is supporting vacuum insulation development in a limited way as part of its building materials R&D program. However, funding is grossly inadequate. We urge the Congress to provide an additional $2.0 million in FY92 specifically for advanced insulation development bringing the total for this area to about $3.0 million. Also, we suggest designating the advanced insulation development as a separate program area in order to increase its prominence. Additional funding would enable accelerated development, prototype construction, and testing of various concepts including silica aerogel, hard vacuum approaches, powder panel approaches, and gas-filled insulating system. Also, a variety of applications should be explored including walls, appliances, and automobiles.

Integrated Resource Planning

Although the Administration is requesting roughly a $2.0 million increase in this area, it is much less than the $6.5 million increase that DOE suggested to OMB. Additional funds are needed for demand side management activities including promotion of innovative demand side management techniques, program monitoring and evaluation efforts, and information dissemination. Also, additional support in the area of regulatory analysis is needed, particularly related to analyzing and disseminating techniques for providing utilities with financial incentives for investing in cost-effective energy efficiency measures. We suggest that these program areas be increased from the requested level of $5.0 million to $10.0 million in FY92.

Hybrid Electric Vehicles

In the transportation sector, the Administration has proposed a large increase for battery development for vehicles ($27.0 million requested). However, the Administration has proposed a decrease in the area of systems development for electric vehicles ($5.1 million requested for FY92 compared to $7.3 million in FY91). This is unfortunate given the opportunities to apply electric batteries to vehicles in the near term. We urge the Congress to provide an additional $3.0 million specifically for the task of developing and testing prototype hybrid electric vehicles (i.e., vehicles that contain both electric batteries and a relatively small internal combustion engine). Such vehicles potentially offer very high efficiencies since the internal combustion engine can be operated at optimal load. Some prototype hybrid vehicles already exist. Hybrid propulsion systems need to be refined and optimized and tested in actual vehicles. Also, research is needed in related areas such as regenerative breaking and transmission systems for hybrid vehicles.

Many other examples of R&D projects that could make a useful contribution to enhancing our nation's energy efficiency are covered in the alternative conservation budget. If the Chairman permits, I would like to insert this document into the hearing record.

Thank you for the opportunity to present these views. We look forward to working with the Subcommittee on this important matter.

Table 1

SUMMARY OF FY92 ALTERNATIVE BUDGET FOR ENERGY CONSERVATION
(Million Dollars)

Program Area	FY 90 Actual	FY 91 Actual	FY 92 Request	FY 92 Alternative
Building Technologies	30.0	43.1	54.2	92.3
Transportation Technologies	68.4	83.8	111.2	127.0
Industry Technologies	75.8	83.5	101.9	111.9
Utility Technologies	3.4	4.2	6.8	21.3
Subtotal - R&D	177.6	214.6	274.1	352.5
Technical and Financial Assistance	227.1	276.5	48.3	405.8
Policy and Management	2.0	3.9	3.6	5.6
TOTAL	406.7	495.0	326.0	763.9

Mr. SCHEUER. Thank you very much, Howard Geller.

Charles Guinn?

Charles Guinn is Deputy Commissioner for Policy Analysis and Planning for the New York State Energy Office in Albany and he is a board member of the National Association of State Energy Officials.

I should have said that Howard Geller represents the American Council for an Energy Efficient Economy.

Please proceed, Mr. Guinn.

STATEMENT OF CHARLES R. GUINN, DEPUTY COMMISSIONER FOR POLICY ANALYSIS AND PLANNING, NEW YORK STATE ENERGY OFFICE, ALBANY, NY, AND BOARD MEMBER, NATIONAL ASSOCIATION OF STATE ENERGY OFFICIALS

Mr. GUINN. The Administration's commitment to energy efficiency and renewable energy sources is minimal at best. The President's budget proposal calls for 1.6 percent of DOE's budget to be spent on energy efficiency programs; the very programs that the National Energy Strategy's outreach hearings record show to be the public's top priority. I don't have to go any deeper than that that at 1.5 percent it's certainly not much of a priority.

Unfortunately, the National Energy Strategy called for a strong partnership between the States and the Federal Government, however, the DOE budget, once again, proposed elimination of Federal funding for the State and local assistance programs. This is a very curious step in developing a partnership, especially in light of what's been going on lately and especially in light of the call by the National Academy of Sciences that if you want to deal with global warming you have to start with increasing efficiencies.

As Congress goes forth with a host of programs for a comprehensive energy strategy, I just want to remind you all to not lose sight of the fact that these State programs are terribly important. They are terribly important because States are very important in dealing with energy and you need an advocate agency at the State level.

The National Energy Strategy is unbalanced to the detriment of energy efficiency and renewable resources. This obvious flaw in Federal policy planning may have resulted form not integrating energy and environmental planning. The environmental consequences of energy actions requires not only integrated policy planning but internalizing the environmental externalities to the degree possible, a point which——

Mr. SCHEUER. Explain that phrase for the record.

Mr. GUINN. For the record, we know that the cost of spewing the residual of energy production and consumption costs something. We know what the control costs could be. We have an increasingly better understanding of what the damages are. We know the bill for importing oil is not zero. If you begin to internalize those costs, in other words, by the way New York has done it in bidding for power plants is adding about a 25 percent charge to the cost of certain energy production. But to get it right you basically have to take account of those environmental externalities.

It is the damage cost to the environment of the production and use of energy. It's an environmental energy. It would be the air pollution impacts. It could be the land and water impacts to production.

Mr. SCHEUER. An indirect added to cost to energy.

Mr. GUINN. Right.

Mr. SCHEUER. Do you hide from the cost of remediating environmental damage?

Mr. GUINN. Right. For example, in a standard that you might set for efficiency of any kind of equipment, it would be logical to add to the actual fuel costs this environmental externality cost and try to get the life cycle cost right.

Mr. SCHEUER. Right. Please proceed.

Mr. GUINN. The States understand the need for a balanced comprehensive energy policy including an aggressive set of efficiency programs, however, the Federal Government, except for prodding by Congress, has been inactive until recently. The States have been doing a lot. I was asked to give some examples of what New York has done, and this is just an example of what one State is doing. Most of the States are doing quite a bit.

New York has integrated its energy and environmental planning activities in the development of a comprehensive State energy plan. Governor Cuomo, by executive order, ordered that the State energy office, the Department of Public Service, and the Department of Environmental Conservation jointly develop, in a common planning process, energy and environmental initiatives. This plan recommended a series of actions that if carried out over the next 20 years result in a growth in energy demand of only 2 percent instead of 19 percent and a fossil fuel growth of 7 percent rather than 30 percent.

One of the important elements of this plan was directing New York State utilities to meet a target of reducing energy and peak demand by 8 to 10 percent by the year 2000 and increasing to 15 percent in 2008. Our public service commission then adopted these targets and ordered the utilities to incorporate them into their long range demand side management plans. They by and large have and are on the path to meet these targets.

The Public Service Commission, in order to cause the utilities to eagerly embrace this concept, are reforming rate-making to provide incentives to utilities to invest in energy efficiency and be held harmless for lost revenues due to their demand side management programs. Each of our utilities has such an incentive system in place, which frankly is why they are pursuing these programs very vigorously.

Another that New York—as well as many States are very active in—are in building codes. We've been doing building codes for over 10 years. Currently we are up—we have a comprehensive update that has just been completed, which includes lighting equipment standards for lamps and luminaries installed in new commercial buildings.

This is an example of the types of things that States do. Standard setting by New York State and other States several times have prompted the Federal Government to follow by adopting State standards nationally. We hope that Congress will assert Federal leadership by adopting strong efficiency standards. The States are prepared, if necessary, to act if the Federal Government does not.

The area of State facilities—the Governor issued an executive order in 1990 which requires State agencies to initiate energy efficiency programs which would achieve a 20 percent improvement in energy by the year 2000.

To capitalize this program, money is coming from our State power authority, from controlling overcharge funds, and we are maximizing the use of utility programs, including bidding demand side management programs for State facilities.

Let me just wrap to say that we do have a pilot home rating system underway between our home builders, one of our utilities, and ourselves. We have invested over $360 million in petroleum overcharge money, which saves about $1.1 billion a year, and we've had a series of audit programs in place in New York for well over 10 years which have resulted in 9,000 audits for industrial customers and 20,000 audits for small business folks.

My basic conclusion is that the States have been a laboratory forever for what can or can't work. We have been innovative, especially in the field of energy efficiency. I just hope the Federal Government will follow our lead.

[The prepared statement of Mr. Guinn follows:]

TESTIMONY
OF

CHARLES R. GUINN

Deputy Commissioner, New York State Energy Office

on behalf of

THE NEW YORK STATE ENERGY OFFICE AND
THE NATIONAL ASSOCIATION OF STATE ENERGY OFFICIALS

before the

SUBCOMMITTEE ON ENVIRONMENT
Committee on Science, Space and Technology
RE: Department of Energy's Budget Request and the National Energy Strategy

APRIL 17, 1991
Washington DC
9:30 A.M.

TESTIMONY

Chairman Scheuer, Subcommittee members, I am pleased to have the opportunity to appear before you today to discuss the Department of Energy's budget and the National Energy Strategy, especially those elements which deal with energy efficiency and renewable energy.

I am the Deputy Commissioner for Policy Analysis and Planning of the New York State Energy Office and past Chairman of the National Association of State Energy Officials (NASEO) and I am testifying on behalf of both New York State and NASEO. NASEO is an organization composed of energy offices in 50 states, territories and the District of Columbia.

Mr. Chairman, the Administration's commitment to energy efficiency and renewable energy sources is minimal at best. The President's budget proposal calls for 1.6 percent of DOE's budget to be spent on energy efficiency programs; the very programs that the National Energy Strategy's outreach hearings record show to be the public's top priority for the future. Clearly, the Administration's priorities as demonstrated in the budget proposal do not follow the Administration's rhetoric or the desired priorities of the American public, and, in fact appear to ignore commitment to energy efficiency and renewables technology.

The President's budget proposal even went so far as to eliminate federal funding for energy activities carried out through the Department of Energy's State and Local Assistance Program (SLAP), including the State Energy Conservation program (SECP), the Institutional Conservation Program (ICP), the Energy Extension Service (EES) and the Weatherization Assistance Program. Fortunately, Congress has continued to support these programs, despite repeated Budget requests to eliminate the programs. Last year, for the first time in a decade, these programs saw an increase and the House Budget Committee has recommended further increases. We believe that had Congress not shown this strong leadership in support of energy efficiency appropriations, many state energy offices would have been forced to shut down, and many vital energy efficiency initiatives discarded.

The importance of an advocate agency for energy efficiency and renewable resource development in the State government cannot be overstated. We hope that Congress will continue to require the Federal Govenment to support these activities. The State's have a major role in energy regulation, transportation, housing, building standards, economic development, natural resource management, education and environmental protection. An effective advocate for energy efficiency and renewables can have a major influence in all these areas. It is hoped that the Federal Government would support the states efforts and work toward developing a strong partnership to advocate energy efficiency and renewables technology development.

Unfortunately, the Administration's National Energy Strategy (NES), while acknowledging the critical role of the States, once again proposed elimination of federal funding for the SLAP energy programs. A curious step in developing a partnership. This budget request is especially incongruous in light of the recent events in the Persian Gulf and the acknowledgment by the National Academy of Sciences that the first step in slowing global warming is increased efficiency. As a plethora of comprehensive energy strategies are floated this year we should keep in mind that a balanced policy includes support for programs that work, including SECP, EES, ICP and Weatherization. This Committee has jurisdiction over the EES program which provides energy outreach services. Funding of $10.3 million would improve the capability of this program to achieve its objectives.

The potential for efficiency and renewable technologies to meet a major portion of increased national demand for energy has been documented by numerous studies including DOE's white papers that were prepared as an input to the NES development and studies of the Electric Power Research Institute. Unfortunately, the NES proposed by the Administration is unbalanced to the detriment of energy efficiency and renewable resources. Nearly every reviewer of the proposed strategy has reached this conclusion; therefore, I will not belabor the point.

This obvious flaw in Federal policy planning may have resulted from not integrating energy and environmental planning. The environmental consequences of energy actions requires not only integrated policy planning but internalizing the environmental externalities to the degree possible. The recent National Academy of Sciences report, "Policy Implications of Greenhouse Warming", which urged increased efficiency is an example of the results of an integrated approach.

The States understand the need for a balanced comprehensive energy policy including an aggressive set of efficiency programs. The Federal Government, except for prodding by Congress, has been inactive until recently. In contrast, the States have continued to move ahead in developing innovative, result-oriented energy programs. We believe that the Federal Government could benefit from our experiences both in terms of what works and what doesn't. I will use New York's experiences as an example.

Energy Planning

New York has integrated its energy and environmental planning activities in the development of a comprehensive State Energy Plan. Governor Cuomo, by executive order, directed that the State Energy Office, the Department of Public Service and the Department of Environmental Conservation jointly develop, in a common planning process, energy and environmental initiatives that improve our environment, increase our economic vitality and reduce our dependence upon foreign oil.

The plan set long-range planning objectives with regard to energy efficiency, fuel diversity and emissions reduction, and set specific implementing policy and program ideas for achieving those objectives. If the recommendations of the plan were carried out, we estimated that over the next 20 years, energy used by New Yorkers would increase by only two percent rather than the 19 percent anticipated under recent trends. Fossil fuel consumption would increase only seven percent rather than the projected 30 percent.

Our plan demonstrates how energy policy can serve our common environmental goals, instead of frustrating them. The cornerstone of achieving our objectives was and remains energy efficiency.

Electric Energy Efficiency

The Plan directs New York's utilities to meet a target of reducing energy and peak demand by 8-10 percent by the year 2000, increasing to 15 percent by 2008 if economically justified. The New York Public Service Commission adopted these targets and ordered the utilities to incorporate them into their long range demand-side management plans.

New York's investor-owned utilities have made substantial progress in implementing demand-side management programs which focus on increasing the efficiency of customer's energy use rather than building new electricity generation to meet growing demand.

The energy and peak reductions achieved from utility DSM have increased dramatically as a result of increased budgeting from $13 million in 1985 to $425 million for 1991-1992. Peak reductions and energy savings have also increased dramatically from a peak reduction of 25 Mw in 1986 to a peak reduction of 306 Mw in 1990 with an annual energy savings of 263 gigawatt hours (Gwh). The utilities' 1991-1992 plans propose to continue to expand the delivery of DSM programs across the board to all customer classes. In the aggregate, the programs aim to reduce summer peak demand and annual electric usage by 960 Mw and 2000 Gwh respectively, during 1992.

This substantially expanded commitment from the utilities to implement full-scale DSM programs places most utilities on a path that approaches the State Energy Plan target of meeting an 8-10 percent reduction in both energy and peak demand by the year 2000 with attendant economic and environmental benefits.

Utility demand-side activities continue to move beyond basic research and development to designing of effective programs that have been proven to deliver savings. New programs being implemented in New York include direct installation programs for commercial sector lighting and low cost measures for residential customers, and new construction design programs to minimize lost opportunities in the new building sector.

The New York Public Service Commission is reforming ratemaking to provide an incentive to utilities to invest in energy efficiency and to be held harmless for lost revenues due to their demand-side management programs. Each of New York's electric utilities has a demand-side earnings incentive in place which allows them to recover lost revenues and earn an incentive on successful energy efficiency programs. Incentive regulation is now expanding in the State to include rewards for efficiencies in generation performance and customer service as well. Such reforms are necessary for the utilities to embrace aggressive demand-side management programs and efficiency programs.

Energy Conservation Construction Code

The Energy Office is responsible for administering, interpreting, and when needed, amending the State Energy Conservation Construction Code which mandates that economically reasonable energy conservation techniques be used in the design and construction of all new public and private buildings. A comprehensive update of the Energy Code has been completed which includes the unprecedented development of standards for lighting equipment including lamps and luminaires installed in new commercial buildings. For buildings affected by these revisions, total energy consumption will be reduced by about 14 percent, representing a savings to building owners of over $2.2 billion by the year 2000. The lamp and laminaire requirements are the first to become effective anywhere in the nation, and like New York's ballast standards (which became the model for national standards), could dictate future directions for manufacturers, other states, and eventual enactment of national standards. Standard setting by New York State and other states has several times prompted the Federal Government to follow by adopting the State standards nationally. We hope that Congress will assert Federal leadership by adopting strong efficiency standards. But States are prepared, if necessary, to act if the Federal Government does not.

State Facilities

Governor Cuomo issued an executive order in 1990 which requires State agencies to initiate energy efficiency programs which would achieve a 20 percent improvement in energy use by the year 2000. Implementation of the executive order is well underway, with State agencies submitting plans to the State Energy Office and the Division of the Budget to achieve significant energy savings. The Agency plans target efficiency improvements in State facilities which, when implemented, are expected to save New York between $25 and $30 million annually in energy costs. The New York State Power Authority will provide $50 million to help capitalize this program. The State has proposed to use oil overcharge funds for this purpose also. Utility demand management programs, including bidding programs, are also being used to provide funding. New York is targeting efficiency projects in state buildings to put together demand reduction bids to utilities, in an effort to leverage more money for state building initiatives.

Home Rating System

The Plan recommended development of a home rating system for new housing so that buyers can shop around for energy efficiency as they now can for appliances and automobiles. Also, such a rating system would provide an incentive for builders to build beyond the State Building Code efficiency standards.

The New York State Energy Office, the Energy Research and Development Authority, the New York State Home Builders Association and New York State Electric and Gas Corporation (NYSEG) have joined to create a rating program for new home construction. The program will operate under a not-for-profit corporation, which will recognize highly efficient homes that operate at least 25 percent above the thermal performance standards of the Energy Conservation Construction Code. The program will initially be implemented on a pilot basis in two of NYSEG's service districts as part of their demand-side management programs. Our hope is that this rating system will be easily transferred to all areas of the State.

Overcharge Investment

New York has invested over $360 million in recovered petroleum overcharge money for energy efficiency programs and services that provide direct benefits to New Yorkers in all sectors. These services range from technical assistance and energy related advice in the form of free energy surveys to financial assistance, such as low-interest loans and rebates for energy efficient equipment and products. These efforts have saved over $1.1 billion annually, in energy costs. These programs are available to motorists, small businesses, industries, schools, homeowners, low-income households, governments and others to cut back their energy use and costs. The Institutional Conservation Program (ICP) and the Energy Investment Loan Program (EILP), for example provide direct grants and loan subsidies directly for energy efficiency project measure implementation, to offset first cost investment barriers.

Audit Programs

New York's energy efficiency audit programs have been in place for a long time.

The residential audit programs carried out by the utilities under the state Home Insulation and Energy Conservation Program (HIECA) of 1978 have resulted in savings of over 700 million barrels of oil equivalent since 1978. The award winning Energy Advisory Service to Industry (EASI) Program managed by the Energy Office has resulted in over 9,000 free energy surveys being provided to businesses, industrial firms, agribusinesses and not-for-profit organizations. Annual energy savings of over $100 million will accrue as a result of the recipients implementing the measures recommended in their surveys. Another Energy Office program, the Small Business Energy Efficiency Program (SBEEP) has resulted in over 20,000 audits.

Competitive Bidding

Under the direction of the Public Service Commission, New York's investor-owned utilities are now completing an initial round of competitive bidding programs that will provide nearly 1300 megawatts of capacity and demand reduction by 1995. New York State, recognizing that future electricity supplies should reflect their environmental costs to society, was the first state in the nation to incorporate environmental externalities in utility competitive bidding programs for new electricity supplies.

By integrating demand-side bidding with supply bidding, and incorporating environmental externalities in the scoring, energy efficiency projects are looked on as much more favorable and cost-effective. New York utilities had solicited about 200 Mw of demand reduction and had received close to 400 Mw in bids from 108 project sponsors.

Additionally, the State Energy Office, on behalf of the Department of Corrections and the State University of New York, proposed the State's first bid for delivering demand-side management savings in the New York State Electric and Gas Corporation's (NYSEG's) competitive bid solicitation. The first phase of NYSEG's evaluation, completed in March, selected the State's 2.3 Mw bid into its initial award group. Negotiations are underway to determine whether the State's bid will be in the final award group.

New York State was the first in the nation to require utilities to factor the cost of environment externalities into the procurement of new electricity and demand-side resources through a competitive bidding process for acquire new electricity supply and demand reducing resources. The effect of this empirical accounting for externalitries, including cost factors for air emissions, water and land impacts is to increase utility avoided costs thereby increasing the number and types of demand-side programs that are cost effective, and favoring cleaner burning fuels and technologies in electricity generation.

The New York State Public Service Commission rules that the cost of mitigating externalities should be valued at roughly 25 percnet of estimated avoided production costs meaning that a competitively bid project achieving the minimum score on all environmental factors but scoring 25 percent better on price than an environmentally clean project would be considered equally desirable, all else the same. Utilities are required to evaluate demand-side programs using a total resource cost test primarily with the inclusion of an environmental externality component. This makes the test more closely resembles a societal cost test, which is preferred for making economic resource decisions.

Conclusion

New York's approach to improving energy efficiency has focused on a whole systems model of energy use. Through a combination of government sponsored and utility industry demand-side management initiatives, all sectors of the economy have the opportunity to participate in energy efficiency programs to reduce energy consumption -- be it oil, gas, coal or electricity.

Since release of the 1989 State Energy Plan, New York has succeeded in assembling an energy efficiency infrastructure that is one of the most comprehensive and innovative in the nation. New York State has embarked upon a number of initiatives that will encourage energy efficiency activities and guide energy efficiency decision making well into the future.

This policy framework consists of several activities initiated with the implementation of recommendations contained in the 1989 State Energy Plan. These initiatives are both broad in scope and varied with regard to end-use fuels being affected, and in enhancing institutional awareness of energy efficiency potential.

Our Federal Government must take seriously the voices across our nation calling for a greater commitment to energy efficiency and renewable technologies and to assemble an energy strategy that can guide prudent energy policy and decision-making through the end of this century. HR 776 and the renewable energy incentives in HR 780 introduced by Mr. Sharp go a long way towards achieving these objectives.

Energy efficiency must be a cornerstone of an aggressive National Energy Strategy which deals with consumer costs, balance of payments, environmental quality and global warming. The Strategy released by the White House fell far short of what is needed. Some measures such as precluding the establishment of efficiency standards for lamps would be a step backwards.

The National Energy Strategy should build on the initiatives of States such as New York, Washington and California and many others to improve the efficiency of buildings, appliances and the way we procure and deliver energy. Our Federal system allows the States to be the laboratories of innovation. We have been innovative especially in the field of energy efficiency. The Federal Government should follow on our lead.

Mr. SCHEUER. Thank you very much, Mr. Guinn. I commend you, and any representative from the State of California who might be in the room, for the really outstanding leadership role that New York State is playing along with California to show the way for the rest of the States and the Federal Government.

Dr. Art Rosenfeld.

STATEMENT OF DR. ARTHUR H. ROSENFELD, DIRECTOR, CENTER FOR BUILDING SCIENCE, LAWRENCE BERKELEY LAB, BERKELEY, CA

Dr. ROSENFELD. Good morning, sir. My testimony is fairly long, so in my 5 minutes—which I will start right now—I will point to some of the figures and tables and try to get you through them in four and a half minutes.

The first point I want to make is that money to R&D—Federal money to R&D—has been enormously productive. I'm going to look back a little at the last 10 years and show that it has paid off about 10,000 to 1 in our lab, and maybe 1,000 to 1 in the whole program, and say that it's inconceivable that we can't continue to get such gains over the next few years.

Mr. SCHEUER. I hate to interrupt, and I will try to control myself until all the witnesses are heard, but those are unbelievable figures. When we do cost/benefit analyses of other Federal programs, like the Head Start program, the GI Bill of Rights, seat belts, inoculations, preventative health inoculations—the very best of them go 7 to 12 to 1. Every dollar invested you get back $7 to $12 or $10 to $15. I've never heard of a program that had 1,000 to 1.

Dr. ROSENFELD. That's why I made this table. I hope you'll look at it. It's on page 3 of the testimony.

What it is, Mr. Chairman, is an update of a paper that Howard Geller and I and some of us from LBL wrote back in 1987 when budgets were being cut severely.

Mr. SCHEUER. Excuse me. What is LDL?

Dr. ROSENFELD. Lawrence Berkeley Lab—LBL.

Mr. SCHEUER. Thank you.

Dr. ROSENFELD. The beauty of this table is that since 1987 these products have actually come on the market. So if you look—the three parts I look at are high frequency ballasts for fluorescent lamps, compact fluorescent lamps, which came from the high frequency ballast possibility, and then a low emissivity or heat mirror windows.

The beauty of this table is I don't have to make up numbers about what the market is going to do at saturation. I can tell you that there are 50 million compact fluorescent lamps out there and each one is going to save $50 worth of electricity in its lifetime. I can do that arithmetic without having to be very hypothetical. It also says on this table, in terms of low emissivity windows, that they are already sold in the 5 years—in the last 5 years—200 million square feet. I know that each square foot saves about a tenth of therm year and I can do the arithmetic.

If I take the savings in the bank, by golly, for the American consumer, it turns out to be $5 billion, so far. When these products saturate the market—and they will—then it's going to turn out to be savings of $16 billion a year. We didn't spend more than maybe $16 million getting there. That's 1,000 to 1 except that the savings are per year and they're going to keep going for some time. That's how I come to these absolutely astounding figures.

The point I want to make about this is, Why are they so astounding? This is the next point I make and I think it's——

Mr. **Scheuer.** What has been done about it? Why hasn't that fantastic window of opportunity been walked through, run through, let through, flown through by the Federal Government?

Dr. **Rosenfeld.** The statement, I guess, by the Federal Government, at least under the Reagan and Bush Administrations, has been that "the market" tends to do such things. The number I would like to point out to you, Mr. Chairman, is this—in the United States, the country as a whole puts back about 2.5 percent of its gross national product in research and development. Some of that is a necessity which we're not going to get from the building industry. If you're Boeing Aircraft, you better do research or you won't sell planes. If you're an electronic company, you better do research or you won't sell computers.

But even in what are called mature industries, the rule of thumb is that you have to put 1 percent of your sales back into research. Mature industries is really sort of a euphemism for dying industries. It's automobiles, appliances, steel, concrete, and so on. Even those industries spend 1 percent.

In the buildings industry, our energy bill is $200 billion a year for lights, fuel, and so forth and so on. What do we put back? Nothing from the industry because it's entirely fragmented so that there are just—mom and pop can't do the research—and the Federal Government puts in—what is it—$43 million. That's one part in 2,000, not 1 percent.

So in the buildings industry, where we're eking along with about one twentieth of the minimum—and the result is that when an actual lab gets into the business and looks around and says, "What can I do?" it's just like shooting fish in a barrel. You can't lose.

But the rule has been in the last 10 or 12 years that the market will do all that. That's why there has been very little done. That's my sort of general argument.

[The prepared statement of Dr. Rosenfeld follows:]

THE ROLE OF FEDERAL RESEARCH AND DEVELOPMENT IN ADVANCING ENERGY EFFICIENCY

FOR HEARING ON DOE CONSERVATION BUDGET REQUEST

Statement of
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Before James H. Scheuer, Chairman
Subcommittee on Environment
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

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INTRODUCTION

Five years ago, I co-authored a paper [Geller et al., 1987] estimating energy savings from efficient technologies developed at Lawrence Berkeley Laboratory (LBL) and Oak Ridge National Laboratory (ORNL). In that paper, we predicted energy savings of $50 billion when seven specific technologies achieved market saturation. These technologies were developed, and their market saturation advanced, through a federal research and development (R&D) investment of only $16 million.

I am happy to report that, only five years later, actual experience has surpassed our predictions. I will discuss the status of the two energy efficient technologies developed at LBL: high frequency ballasts and low-emissivity (low-E) windows. I have requested, but not yet received, information from other DOE laboratories on the performance of the other technologies, but I believe they have also been remarkably cost effective.

Originally, we predicted savings of $28 billion from DOE R&D funding of $6 million for development of high frequency ballasts and low-E windows. Now, due to rapid market saturation in the ensuing years, these two technologies alone have **already realized savings of almost $4 billion** and predict that when full saturation is reached savings will be nearly $50 billion. Also, because the development of high frequency ballasts advanced the development of compact fluorescent lamps (CFLs) by about 5 years, we add another $35 billion in savings from CFLs when they reach saturation. Thus, **$6 million in federal R&D funding has resulted in predicted annual savings of over $82 billion.**

After discussion the update of the benefits and costs of DOE-sponsored research, I will discuss expansion of existing programs in Section II and formation of new programs in Sections III, IV, and V.

I would like to emphasize that I am expressing my own views, and am not speaking for the University of California or Lawrence Berkeley Laboratory.

I. COSTS AND BENEFITS OF DOE-SPONSORED R&D ON THREE SUCCESSFUL TECHNOLOGIES [TABLE 1]

Table 1 provides information on the economics of high frequency ballasts, CFLs, and low-E windows. I will discuss this table in depth following a brief description of these three technologies.

A. High Frequency Ballasts

Ballast is the industry name for the power supply for a fluorescent lamp. Energy efficient solid-state ballasts, operating at 50,000 cycles per second, give a pleasant flicker-free light and reduce the energy needed for lighting by 33% over conventional ballasts. These high frequency ballasts were developed through DOE-sponsored research at LBL in the late 1970s. They are now commercially available at a wholesale cost premium of about $8. In 1991, sales of these ballasts should approach 10% of "saturation" of the market.

B. Compact Fluorescent Lamps (CFLs)

Fluorescent lamps are about 4 times more efficient than the 100-year old incandescent. However, before the advent of the the high-frequency ballast described above, power losses at each end of these lamps were so large that it was impractical to make the lamp shorter than about 2 feet. In fact the most popular lengths were and still are 4 and 8 feet. The high-frequency ballast eliminated these end-losses and ushered in the CFL which could be screwed into sockets normally occupied by incandescents. For example, hardware stores now stock 16 watt CFLs which replace 60 watt incandescents; or, more precisely, they replace a series of about one dozen 60 watt incandescents since they burn 12 times longer than incandescents. CFLs, which have also profited from the development of more efficient phosphors, are now cost-effective even without high-frequency ballasts, although these ballasts seem to be taking over the market. We believe that the development of the high-frequency ballast between 1976 and 1980 accelerated the arrival of the CFL by about 5 years, with large associated savings as detailed in Table I. In 1991, CFL sales are already 8% of the market.

C. Low-Emissivity "Heat Mirror" Windows

Heat losses and gains through windows are responsible for 25 percent of all heating and cooling requirements in U.S. buildings (so nearly 4 percent of total U.S. energy use). The Alaskan pipeline, pumping 1.8 million barrels of oil per day (Mbod), just makes up for the natural gas burned every winter to make up the heat lost through U.S. windows.

Although even more energy efficient windows are on the way, I will discuss only the savings of heat using the first generation of low-emissivity (low-E) windows. In the late 1970s, DOE-funded research at LBL, combined with private industry efforts, resulted in the development of double-glazed windows with low-E

Table 1. Economics of Three Energy Efficiency Technologies. An update of Tables 1 and 4 of Geller et al., *Annual Review of Energy* 1987, Vol 12: 357-95.

	HIGH FREQUENCY BALLASTS VS. CORE COIL BALLASTS	COMPACT FLUORESCENT LAMPS (1) VS. INCANDESCENTS	LOW-E (R-4) WINDOWS VS. DOUBLE GLAZED WINDOWS		TOTAL
			Per square foot	Per small window (10 ft²)	
1. UNIT COST PREMIUM					
a. Wholesale	$8	$5	$1	$10	
b. Retail	($12)	($10)	($2)	($20)	
2. CHARACTERISTICS					
a. % Energy Saved	33%	75%	50%		
b. Useful Life	10 years	3 years	20 years		
c. Simple Payback Time (SPT)	2 years	1 year	2 years		
3. UNIT LIFETIME SAVINGS					
a. Gross Energy	1330 kWh	440 kWh	1 MBtu	10 MBtu	
b. Gross $	$100 (2)	$33 (2)	$7 (3)	$70 (3)	
c. Net $ [3b-1a]	$92	$28	$6	$60	
d. Gross Equivalent Gallons (4)	100	40	8	80	
e. Miles in 25 mpg car	2500	1000	200	2000	
4. SAVINGS 1985-1990					
a. 1990 Sales	3M	20M	200M	20M	
b. Sales 1985 through 1990	8M	50M	500M	50M	
c. Cum. Net Savings [4b x 3c]	$750 M	$1.4B	$3B		$5B/5yr
5. SAVINGS AT SATURATION					
a. U.S. Units	600M	750M	14,000M	1400M	
b. U.S. Annual Sales	60M	250M	700M	70M	
c. Annual Energy Savings [5b x 3a]	80 BkWh	110 BkWh	0.3 Mbod		
d. Annual Net $ Savings [5b x 3c](5)	$5.5B	$7B	$4B		$16.5B/yr
e. Factories Needed	-	125	35		
6. EQUIVALENT U.S. SUPPLY 1 baseload "plant" = 5 BkWh/yr 1 offshore "platform" = 10,000 bod	16 "plants"	22 "plants"	30 "platforms"		
7. PROJECT BENEFITS					
a. Advance in Commercialization	5 years	5 years	5 years		
b. Net Project Savings [6a x 5d]	$27.5 B	$35B	$20B		$82.5B
8. COST TO DOE FOR R&D	$3M	$0(6)	$3M		$6M
9. BENEFITS/ R&D COST [7b/8]	9000:1		6500:1		14,000:1

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(1) Calculations for CFLs based on one 16-watt CFL replacing thirteen 60-watt incandescents, burning about 3300 hours/year, assuming that a CFL costs $9 wholesale, or $5 more than the wholesale cost of thirteen incandescents. For retail we take $18 - $8.

(2) Assuming price of 7.5¢/kWh for commercial sector electricity.

(3) Assuming retail gas price of $7/MBtu (70¢/therm).

(4) Assuming marginal electricity comes from oil or gas at 11,600 BTU/kWh, thermally equivalent to 0.08 gallons of gasoline.

(5) Net annual savings are in 1990 dollars, uncorrected for growth in building stock, changes in real energy costs, or discounted future values. See Geller et al., Table 1.

(6) Descended from high-frequency ballasts (only DOE assistance was in testing).

4/29/91

coatings filled with low-conductivity gas such as Argon. These low-E windows resemble the familiar double-glazed ("thermopane") windows but have thin film coatings applied to at least one of the inner surfaces. These films are transparent to light and are nearly a perfect mirror to room temperature heat. This cost-effective film is slowly saturating the market, and has doubled the thermal resistance of old-fashioned "thermopane" from R-2 to R-4. In these "R-" units, a single-glazed window is R-1 and an insulated wall is typically R-11.

Major window manufacturers such as Andersen, Pella, and Marvin now offer low-E windows with R-values from a minimum of R-3.5 up to "superwindows" of R-8. Thus, we can say with confidence that low-E windows will saturate the market, but in fact the R-4 window described in Table 1 will probably be overtaken by R-8 superwindows. In 1990, low-E window sales achieved about 30% of the market.

D. Economics of Three Energy Efficient Technologies - Table 1

Table 1 provides detailed information on the economics of the three technologies just described. I will now describe each of the rows in Table 1 and explain what's new since the earlier tables were published in Geller et al.

1. *Unit Cost Premium.* The economics of these technologies are now calculated using the **wholesale** cost "premium," i.e. the difference between the cost of the energy efficient item and the cost of its predecessor (high frequency ballasts compared to core-coil ballasts, CFLs compared to incandescents, low-E windows compared to conventional double-glazed windows). In the 1980s, retail conservation had to compete with wholesale electricity and gas, but following the new profit rules introduced under the 1990 Collaborative Processes, utilities now buy lamps and windows wholesale for their large conservation programs. Even if retail prices are used, there are not qualitative changes in Table 1. For example, payback times double and net savings will drop by 10%.

2. *Characteristics.* This row describes technology-specific characteristics of useful life, % energy saved, and simple payback time (SPT). SPT is the time it takes to recoup the money invested in an energy efficient technology through its reduction in energy bills.

3. *Unit Lifetime Savings.* These savings are expressed not only in the conventional units of energy and dollars (gross and net) but, for easier visualization, savings have been converted to gallons of gasoline equivalent and how far they will carry the family car. In so doing we assume electricity saved at the margin is produced by oil or natural gas which are largely interchangeable. For example, a homeowner might be pleased to know that purchasing a CFL not only saves the household $28 over the lifetime of the lamp, but also frees up enough energy to drive the family car 1000 miles.

4. *Savings 1985-1990.* What's really new about this table is that this row provides information on actual experience with these technologies since 1985 when Geller et al. was written. For example, during this 5 year period, 50 million windows were sold which will save $3 billion over their lifetime. **Total guaranteed savings from sales of all three of these technologies between 1985 and 1990 are $5 billion over their lifetime.**

5. *Savings at Saturation.* Estimated savings from these technologies, once market saturation has been achieved, are contained in this row. It includes information on the existing U.S. stock of these items, such as the number of light fixtures and windows in residential and commercial buildings. If these energy efficient technologies are installed in all existing fixtures and windows, then market saturation is reached. Our estimates are conservative, however, because they do not include growth in the buildings sector and they do not account for inexorable improvements in the technologies. The calculations for low-E windows are also conservative because they assume average U.S. weather and that all existing U.S. windows are double-glazed. Thus, the low-E savings in Table 1 are only 0.3 Mbod instead of the 1.8 Mbod that are actually lost because of inefficient windows. **Total savings from these three technologies at market saturation will be over $16 billion per year.**

6. *Equivalent U.S. Supply.* Based on the annual energy savings provided in the previous row, we can calculate how many baseload (1 GW) power plants can be avoided when high frequency ballasts and CFLs reach saturation (16 + 22 "plants"). We can also calculate that 30 offshore oil platforms (10,000 bod @ $500 million) will be displaced when low-E windows reach saturation.

7. *Project Benefits.* To determine the benefits that are a direct result of R&D funding for development of a specific technology, we must first estimate the effect of the funding on the commercialization of the technology. We have estimated that these three technologies were advanced by five years, but we freely admit that it is difficult to determine this exactly. We then multiplied the annual savings from each technology by 5 years, giving us an idea of the project benefits from the R&D funding. Thus, the annual $16.5 billion saved becomes a final project benefit of $82.5 billion.

8. *Cost to DOE for R&D.* DOE R&D funding was $3 million for high frequency ballasts, and $3 million for low-E windows. Little DOE R&D funding (testing only) was used for development of CFLs, which inexorably followed the high frequency ballasts.

9. *Benefits/ R&D Cost.* The $82.5 billion savings just described are dramatic when compared to the DOE R&D costs. For high frequency ballasts, the savings-to-cost ratio is 8000:1 and for low-E windows this

ratio is 6500:1. When CFLs are included, these three DOE-sponsored technologies generated an overall savings-to-R&D cost ratio of 14,000:1.

E. R&D Failures

What about R&D failures not shown on Table I? In a diversified research program, some projects should, and do, fail. Perhaps 10% of our projects actually do fail. To account for project failures, we should divide the $82.5 billion in R&D benefits outlined above by the $100 million that DOE has provided over the past 15 years in support of buildings research at LBL. The benefit/cost ratio then drops to 800:1, which is a bit conservative because it does not account for other large, but less flamboyant successes. (For descriptions of other successful programs, see Geller et al., 1987 and DOE Success Stories 1990.) So, **we believe that DOE's R&D support of buildings research at LBL has about a 1000:1 benefit/cost ratio.**

It will take about 40 years for U.S. oil production to drop from its 1970 peak to 20% of this peak production in about 2010. On such a time scale, R&D, followed by commercialization of these novel conservation technologies takes a long time. Work on both the high frequency ballasts and low-E windows was planned before there was a DOE, and funded starting in 1976. They will reach 50% market penetration in about 20 years. But existing ballasts last another 10 years, and windows at least 20, so full penetration of their energy savings will take 30-40 years.

II. FUTURE R&D

Have we "used up" all the cost-effective R&D opportunities? We do not believe so, for two reasons. First, it's inconceivable that a benefit/cost ratio which averaged 1000:1 for the 15 years could suddenly drop to 1:1 or even 10:1.

Second, the U.S. annual energy bill of $200 billion for the buildings sector is so large, and our publicly supported R&D to decrease it so small (less than $100 million/year, or 1/2000), that we have barely scratched the surface. Most mature U.S. industries reinvest at least 1% of their revenues in R&D. Growing industries such as aviation, electronics, and health care invest far more. But unlike the other energy-using sectors of transportation and industry, the buildings sector is highly fragmented worldwide, so the majority of builders and component manufacturers cannot do research at all. The few large manufacturers that do constitute only a small part of the sector. This explains both why the sector is technologically unsophisticated and why there is a great need for continued DOE research.

In fact, buildings present the largest opportunity for the U.S. to save fossil fuels and money. I participated in the National Academy of Sciences report issued April 10, 1991 on *Policy Implications of Greenhouse Warming* (NAS 1991). This report found that 1800 megatons/year of carbon dioxide can be saved at a net benefit (or at most low cost). Energy savings in the buildings sector accounts for half of this potential savings.

I would like to comment upon the following promising research areas:

A. Windows

In discussing Table 1, we have already mentioned R-8 superwindows that are net energy gainers on a winter day anywhere in the U.S. The next challenge is commercial buildings, where the most serious problem is not cold weather (which can be solved with low-E "heat mirror" windows), but hot sunny days. The current technology used is the ubiquitous "solar control" reflective glazing. Solar control glazing was a great advance, but it darkens the interior space, calling for expensive lighting (which in turn generates heat), and solar control glazing is a poor insulator against cold weather. Now, just making the transition from the laboratory to the market, is transparent "selective" low-E glazing, which reflects both the "near-infrared" half of sunlight (the half which carries heat but no light) and the "far infrared" indoor heat which we still want to save in the winter. These selective low-E glazings now admit the visible half of sunlight, leaving offices daylit all year round. When perfected, this new transparent glazing will save several billion dollars per year. We should enlarge windows R&D to quickly capture these savings.

Also, electrochromic windows (switching from clear to reflective under electric control) will soon become available for buildings and cars. The R-4 low-E window included in Table 1 will already save natural gas equivalent to half the oil production of Alaska, and superwindows and selective windows can save the remaining half.

B. Superinsulation

DOE is now supporting the parallel development of at least four different superinsulation technologies. Some are opaque and can replace CFC-blown foam in appliances and even airplanes; others, like aerogel, are transparent or translucent and can be used not only for appliances, but also for windows and skylights. At LBL, we have developed new panels of gas-filled superinsulation only 2 inches thick, but with a thermal resistance of R-25, about the same as 7 inches of fiberglass (Griffith, 1991). We hope that soon this product will be of comparable cost with fiberglass.

It seems urgent to improve insulation because the space-heating energy bill for U.S. buildings is about $50 billion/year. Even the $10 billion/year of heat that leaks into refrigerators is worth our attention.

C. Indoor Air Quality and Control of Radon and CO

Since energy efficiency affects indoor ventilation rates, we must necessarily address indoor air quality. Radon in homes is estimated to cause 10-20,000 lethal lung cancers each year. In a few of these homes residents are exposed to radon levels well above the occupational health limit for mine workers. These "hot" homes are in geologic "hot" spots, and we need to develop programs to find and mitigate these houses, therby preventing occupants from very rapid accumulation of radon exposures. Such a program would cost $1 or 2 million for 5 years.

Coroners report another 1000 deaths per year from carbon monoxide from old gas heaters with cracked heat exchangers. The true death toll is larger because of deaths reported merely as "heart attack" or "old age". Even the lower limit of 1000 deaths per year is the same as four 747 jumbo jet crashes per year. With funding of $1 million per year for 5 years, we could save these 1000 annual deaths for the foreseeable future. The cost would then be $1000 per life saved for 5 years and nearly zero per life thereafter.

Other indoor air quality improvements include better sensors and controls for indoor comfort and air quality in commercial buildings. Half of the U.S. Gross National Product of $5 trillion is earned by people working in buildings. We restate this by saying that the "productivity" of buildings is $2.5 trillion per year. Better sensors, controls, and service can easily raise this productivity to 1%, or $25 billion per year. This seems to easily justify a "Healthy Buildings" program of several million dollars per year.

THREE NEW R&D AREAS FOR DOE:

- Fellowships in Conservation and Renewables
- Research in Summer Urban Heat Islands
- Technology in Support of Integrated Resource Planning

III. FELLOWSHIPS IN CONSERVATION AND RENEWABLES

It is extremely important that DOE establish fellowships in Conservation and Renewables. DOE currently supports graduate study through national fellowship programs in the Offices of Fusion Energy, Nuclear Energy (50 fellows), Civilian Radioactive Waste Management, Energy Research, Defense Programs, and Environmental Health and Safety. Given our recognition that conservation shaved 35% off the U.S. energy bill during the 13 years of high energy prices following the OPEC oil embargo, it's imperative to appoint fellows to learn the techniques to continue this productive trend. The absence of fellowships in Conservation and Renewables is an anachronism and is inconsistent with the Education section of the *National Energy Strategy*. My experience as a Professor of Physics at the University of California is that many of my brightest students are interested in pursuing studies in the field of energy conservation but are often precluded from doing so because of the lack of fellowships.

An absurd situation that demonstrates the need for Conservation and Renewables fellowships exists at the LBL Center for Building Science. At any given time we have about six fellows who have been sent by their governments to collaborate in our productive programs and learn about building science and technology. **None of them is American!**

We know that conservation can cut $100 to $200 billion from our annual energy bill. We know that renewables can delay the threat of greenhouse warming and that both renewables and conservation can help energy security and the environment. I urge Congress to take an initial small step and authorize 20 new fellowships each year in Conservation and Renewables. Congress should also fund a conservation personnel needs assessment through the Office of Technology Assessment or the National Academy of Sciences.

IV. SUMMER URBAN HEAT ISLANDS

Most American cities are now "Heat Islands," whose downtown summer temperatures have been steadily warming 0.5-1°F per oecade hotter than surrounding areas. There is no evidence that this rise is moderating, and global greenhouse warming will likely add a comparable rise. We estimate that 5-10% of urban electric peak demand today is for additional air conditioning to compensate for heat islands, costing rate payers $1 billion per year. Furthermore, in major cities, there are no smog episodes for temperature below about 70°F, but smog becomes unacceptable by 90°F, so a rise of 10°F, because of past and future heat island effects, is very significant.

White surfaces, shade trees, and street/park trees are three effective measures to reduce the summer heat island effect. White surfaces are the most effective and least expensive measure. Trees which directly shade buildings are twice as efficient as street/park trees in reducing air conditioning. An aggressive research program and beginning of "whitening and greening" can advance heat islands mitigation by ten years, saving $10 billion in energy cost, and $20 billion in avoided generation and air conditioning investments.

We discuss urban trees and white surfaces in three parts: heat island effects, heat island mitigation, and policy issues. Information on the the magnitude and ccst of heat islands are obtained using excerpts from Akbari et al. (1990) and their mitigation using Akbari et al. (1988)

A. Heat Island Effects

Before mechanical air conditioning, people cooled their homes in the summer by surrounding them with trees and painting the walls and roofs white. The disappearance of such practices increases the cooling demand of a home by ~1 kilowatt (kW), and if the home is urban, contributes to a summer 5°F heat island.

Figure 1 depicts Los Angeles temperature highs between the 1870's and 1984. We see a pre-'40's cooling trend and a post-'40's warming trend. Los Angeles, like all California cities, cooled about 2°F as they filled with irrigated orchards, but downtown Los Angeles's high temperatures are now about 6°F higher than they were in 1940. **Figure 2** shows the post-40's warming trend in further detail. We can see that the summer months' average temperature are zooming over 1°F/decade. In Washington D.C. there has been a 5°F increase this century and the temperature increase continues to grow at 1°F every 20 years.

From Fig. 1 and the discussion above, we can estimate the relative effects of whitening and greening Los Angeles. We would like to return at least to 1940 temperatures, a drop of 6°F, and might be able to go

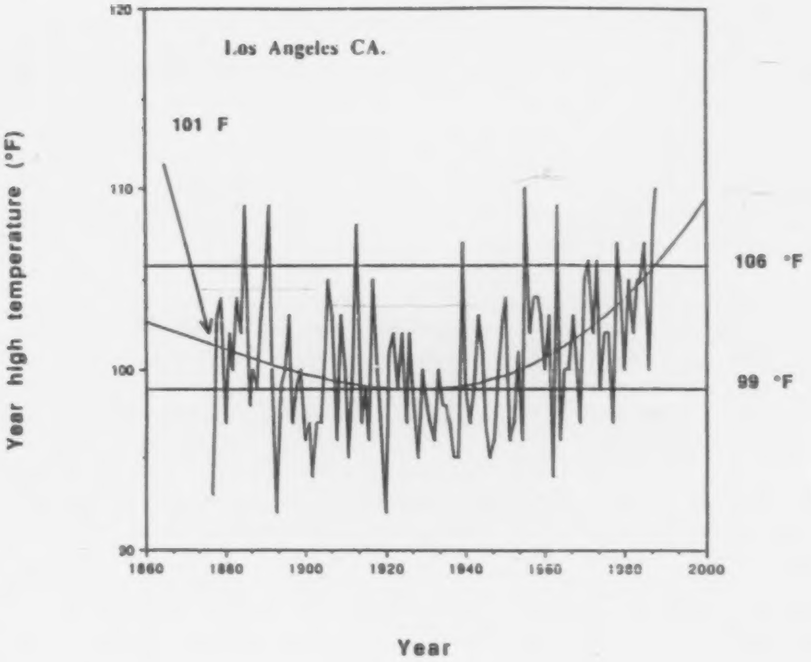

Los Angeles CA.
101 F
106 °F
99 °F
Year high temperature (°F)
120
110
100
90
1860
1880
1900
1920
1940
1960
1980
2000
Year

Figure 1.

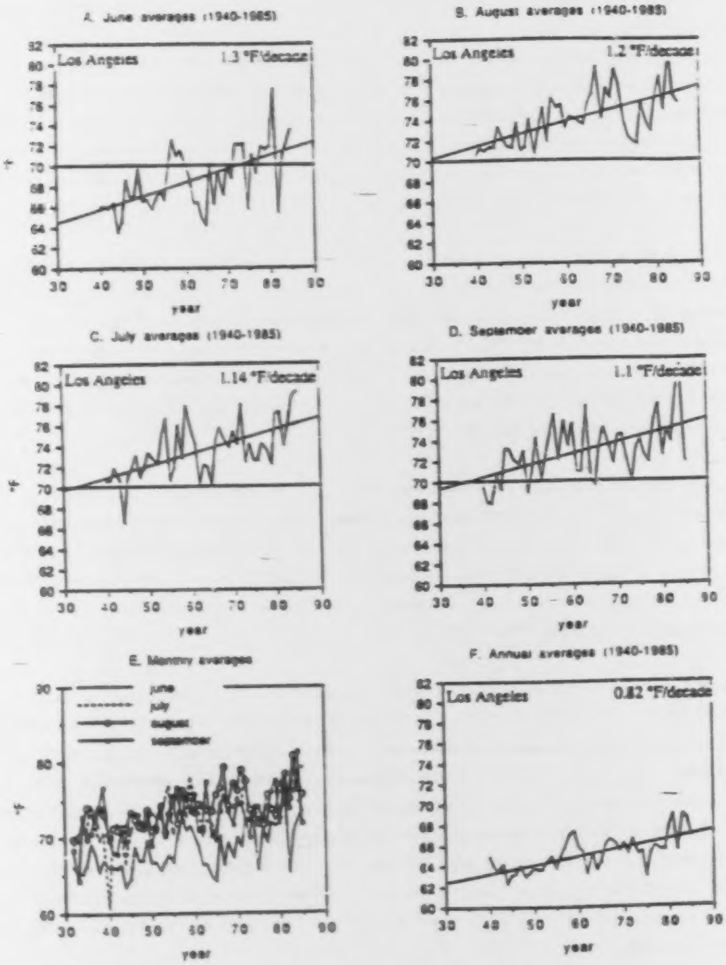

A. June averages (1940-1985)
Los Angeles
1.3 °F/decade
B. August averages (1940-1985)
Los Angeles
1.2 °F/decade
C. July averages (1940-1985)
Los Angeles
1.14 °F/decade
D. September averages (1940-1985)
Los Angeles
1.1 °F/decade
E. Monthly averages
june
july
august
september
F. Annual averages (1940-1985)
Los Angeles
0.82 °F/decade
°F
year
60
62
64
66
68
70
72
74
76
78
80
82
90
30
40
50
60
70
80
90

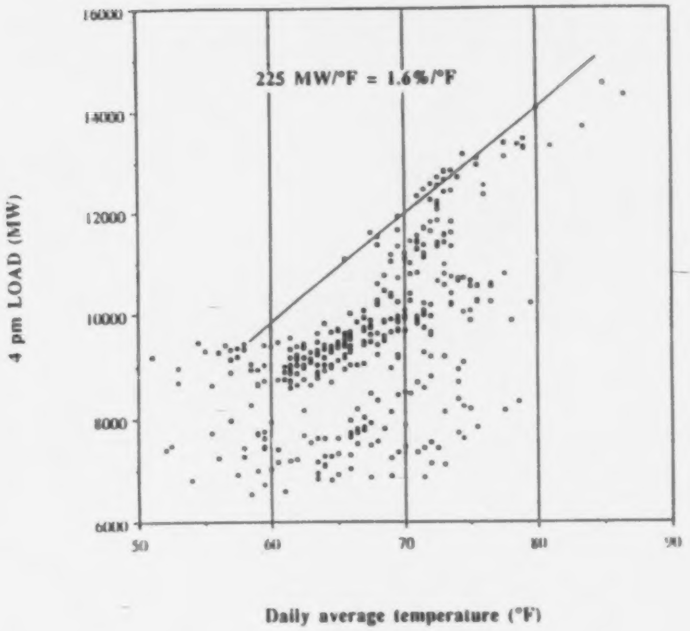
Figure 2.

lower. Of the 6°F target, it appears that about 2°F could come from "greening" (if we can restore the density of trees and vines to the 1940 density of orchards). The remaining 3-4 degrees could be achievable from lightening the color of asphalts, i.e. roofs and roadways -- this should be the cheapest to fix. Those who live in white villages and cities around the Mediterranean have cooled themselves for centuries, and many Middle Eastern cities routinely whitewash their roofs and walls every spring. In Iran, roads are "sanded" with light color sand to keep them cooler, mainly because hot asphalt has its life shortened by squishing out from underneath tires. Of the 6°F, about 1°F comes from actual man-made heat (cars, and electricity) and will be hard to mitigate.

The Los Angeles Basin is served by two utilities: Southern California Edison (SCE) with a capacity of ~15GW and Los Angeles Department of Water and Power (LADWP) with a capacity of ~5GW. **Figure 3** depicts SCE's 4 pm electrical load versus average daily temperature for 365 days in 1986. We see that peak demand increases by 225 MW/°F or about 1.6%/°F. If we add this to the LADWP slope (75 MW/°F), the total slope reaches 300 MW/°F, and for the 5°F rise since 1940, that means ~1.5 GW of heat island-dependent load. If peak electricity is worth 10 ¢/kWh, then this represents $150,000/°F for each hour. **Figure 4** shows a comparable heat island in Washington, D.C.

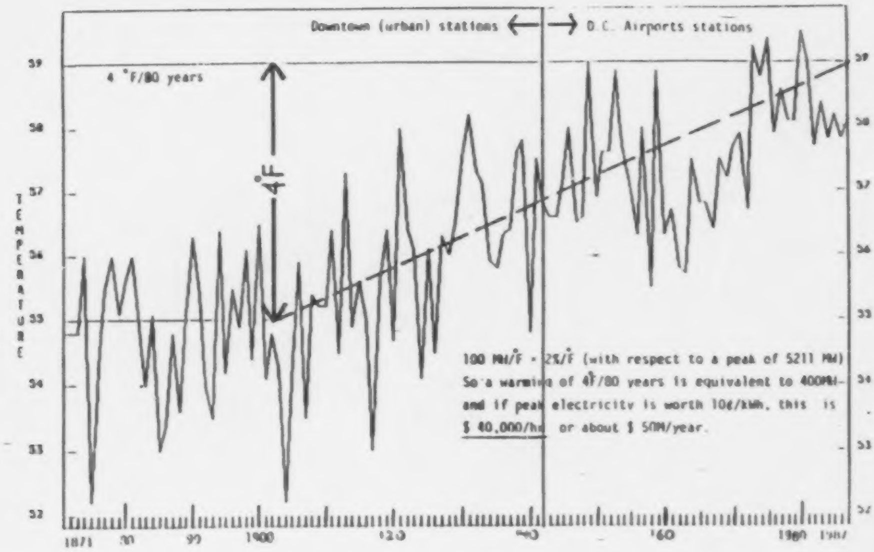
Not only does the heat island increase cooling loads, but it also increases the probability of smog episodes, brought on by the higher urban temperatures. **Figure 5** shows the daily maxima in ozone levels (a measure of smog) for Los Angeles. We see that below ~70°F, smog never exceeds the National Atmospheric Air Quality Standard (NAAQS), but at ~90°F, smog levels are more than twice the NAAQS. Restated, smog goes from tolerable (!) to intolerable in just 20°F, of which one fourth to one third is already attributable to the heat island effect.

Figure 6 projects the frightening future summer temperatures in the LA Basin, assuming that global warming will heat the surrounding as shown in Hansen's Scenario A, with CO_2 equivalent doubling is by 2050 and the So. California coast rising about 6°F. To the Hansen calculation we have added the local heat island, labeled "LA ACTUAL". At 1990 the curve take three forks: "TREND" assumes we continue to do nothing, in which (unlikely) case, LA will rise 18°F by 2050; "FROZEN HEAT ISLAND" assumes we "lighten and green" the Basin fast enough to halt the heat island growth. Even then Los Angeles in 2050 will be hotter than any major city in tropical America today. The third, flat, scenario, labeled "REDUCE HEAT ISLAND TO 1940 LEVEL", assumes we reduce the heat island fast enough to compensate for global warming, and entirely halt the rise in LA summer temperatures. This discussion bring us inescapably to mitigation.



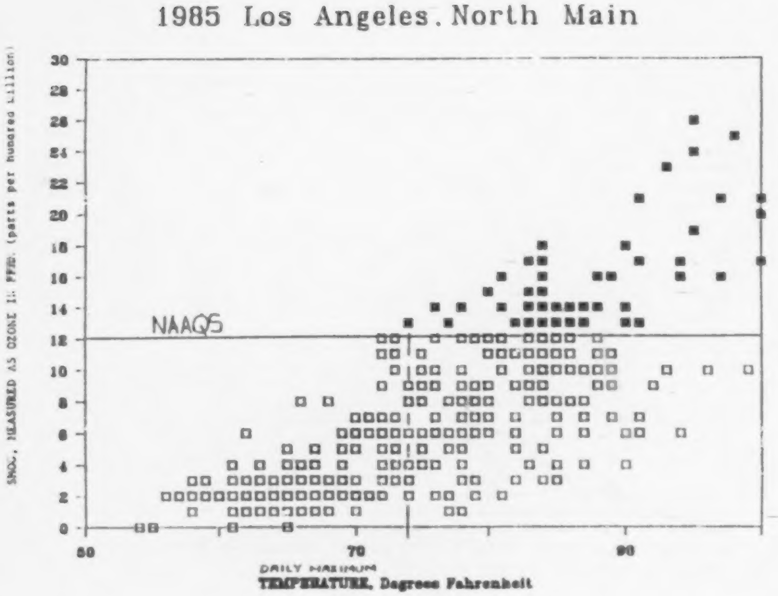
4 pm Load of the S.C. Edison versus Downtown Los Angeles daily average temperature

Figure 3.



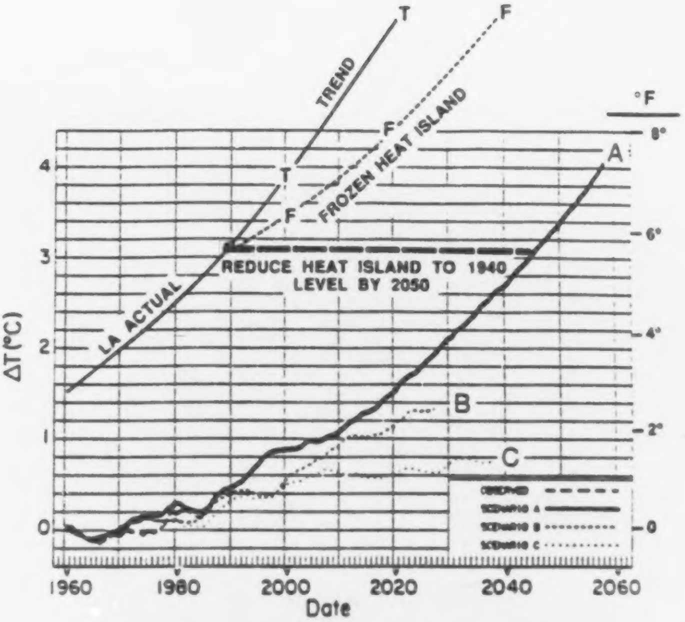
100 MW/°F = 2%/°F (with respect to a peak of 5211 MW)
So a warming of 4°F/80 years is equivalent to 400MW-
and if peak electricity is worth 10¢/kWh, this is
$ 40,000/hr or about $ 50M/year.

Figure 4.



1985 Los Angeles. North Main

Figure 5.



Five-year Running Mean Global Surface Air Temperature Computed for Scenarios A, B, C, 1960-2060. *Scenario A*—exponential trace gas growth, 1.5%/year; *Scenario B*—reduced linear growth of trace gases; *Scenario C*—rapid curtailment of trace gases, no increase after the year 2000. The zero point for observations is the 1951-1980 mean. The zero point for the model is the control run mean. Source: Figures are from J. Hansen, I. Fung, A. Lacis, D. Rind, S. Lebedeff, R. Ruedy, and G. Russell, *Global Climate Changes as Forecast by Goddard Institute for Space Studies Three-Dimensional Model*, NASA Goddard Space Flight Center, Goddard Institute for Space Studies, New York, NY, from *Journal of Geophysical Research*, Vol. 93, No. D8, pp. 9341-9364, August 1988.

The upper curves are the projected temperature in downtown Los Angeles (3 scenarios of the heat island growth + global warming scenario A). By coincidence, global circulation models show that Los Angeles (located on the coast at latitude 34°) will warm at about the rate as the global average. By 2050, under the "Trend" Scenario (1°F/decade growth in the heat island), downtown LA will be 18°F hotter than it was in 1940. With "Frozen" heat island intensity at the 1990 level, the city will be 12°F hotter. With a vigorous program of heat island mitigation ("Reduce" LA heat island to 1940 level), it is possible to entirely compensate for the effect of global warming in LA.

Figure 6.

B. Heat Island Mitigation

Urban light-colored surfaces and trees are two proven and inexpensive measures to reduce summer heat islands and even create summer oases. Trees improve the urban climate and, by shading and evapotranspiration, reduce summer cooling energy use in buildings at only 1% of the capital cost of the avoided power plants and air conditioning equipment. Using light-colored paints and surfacing the asphalt of streets and parking lots with whitish aggregate and sand are even more effective.

In addition to saving energy, urban trees and light-colored surfaces are the most cost-effective ways to indirectly slow the growth of atmospheric CO_2. By reducing the need to burn fossil fuels for generating electricity, urban trees are indirectly about 15 times more efficient at sequestering CO_2 than is rural forestation.

Our calculations indicate that light-colored surfaces and urban trees can save 0.5 "quad" (quadrillion Btu) per year in the U.S. (out of 1991 U.S. energy use of 81 quads) with a payback time of 0.3 to 1.8 years, and decrease CO_2 emissions by about 17 million tons of carbon per year. (See **Table 2**).

Of three possible options: white surfaces, shade trees, and street/park trees, white surfaces are the most effective and least expensive measure. More than half of the savings shown in Table 2 are due to white surfaces. Cities can be whitened rather easily. Most buildings and flat roofs are painted (or resurfaced) every 10 years; in their next cycle, they can be painted white. Also, on streets and parking lots, whiter asphalts and concrete can cover blacktop at low or zero incremental cost. Furthermore, for new buildings, colors can be easily incorporated into building codes.

The other half of the savings from the combination of the direct and indirect effects shown in Table 2 are from the planting of 100 million urban trees. This annual savings of 0.25 quads (22 billion kWh) corresponds to a savings of 8 million tons of burned carbon. A fast-growing tree sequesters carbon from the atmosphere at the rate of ~13 lb per year. Therefore, 100 million forest trees will sequester 0.65 million tons of carbon from the atmosphere, which is only 1/15th of the carbon saved by the same number of urban trees through their reduction in cooling energy use. Another way of looking at this is that to sequester from the atmosphere the same amount of carbon saved by the planting of 100 million *urban* trees would require planting of 1.5 billion *forest* trees corresponding to 1.5 million hectares of forest (a hectare is 2.5 acres, and the total area of Connecticut is about 1.3 million hectares). Since shade trees are twice as effective as street/park trees in reducing air conditioning, more attention should be given to trees which directly shade residential, small commercial, and industrial buildings. An economic comparison of shade trees, street/park trees, and rural trees is needed for the design of an effective heat island mitigation and CO_2 sequestering program. We estimate that an aggressive research program and the

Table 2. **Yearly savings (by 100 million trees/white surfaces) of primary energy used for air conditioning in the U.S. and consequent reductions in released carbon*.**

	Residential **			Small Commercial †			Large Commercial ‡			Total	
	Energy		Carbon	Energy		Carbon	Energy		Carbon	Energy	Carbon
	(%)	(10^{15} Btu)	(M Tons)	(%)	(10^{15} Btu)	(M Tons)	(%)	(10^{15} Btu)	(M Tons)	(10^{15} Btu)	(M Tons)
Direct Savings	10	0.12	4	4	0.03	1	0	0.0	0	0.15	5
Indirect Savings	20	0.23	8	12	0.09	3	5	0.04	1	0.36	12
Total	30	0.35	12	16	0.12	4	5	0.03	1	0.51	17

* Production of carbon (as CO_2) from a peak power plant assumes 11,600 Btu/kWh sold, and ~14,500 Btu/lb. of carbon.

** **Residential.** US annual residential cooling electricity use is ~100 BkWh/yr, corresponding to 1.2 quads. We assumed 3 trees (plus light surfaces) for 50% of our 50 million air conditioned homes, so 75 million trees (plus light surfaces).

† **Small Commercial.** US uses 65 BkWh (= 0.75 quad). We assumed 30% coverage by trees (25 million more trees).

‡ **Large Commercial.** US uses 65 BkWh (= 0.75 quad). We assumed no additional trees.

beginning of whitening and greening can accelerate the heat island mitigation by ten years, saving $10 billion in electric bills and over $20 billion in avoided generation and air conditioning investments.

C. Policy Issues

Although we have scoped and preliminarily ranked the heat island mitigation measures, research is needed to understand many aspects of these measures:

1. *White Surfaces and Trees.* Trees cool the city by evapotranspiration, but they only reflect 20 to 25 percent of incident solar radiation. We need to study the optimal combination of white surfaces and trees.

2. *Direct and Indirect Savings.* Presently, we can model the direct savings of white surfaces and trees using building energy simulation codes. Further research is needed to model indirect savings.

3. *Shade Trees, Street/Park Trees, and Rural Trees.* Trees save cooling energy and reduce atmospheric CO_2 pollution. We already know that it is very cost effective to plant trees which shade buildings directly. In addition to their direct effects, shade trees would also contribute to heat island mitigation by evapotranspiration. Trees on streets, highways, and parks save energy only by mitigating heat islands, hence they are only half as effective as shade trees. Rural trees do not save energy, but do sequester CO_2 from the atmosphere, are inexpensive, and have a high rate of survival. We need to compare the economics of all three types of trees, in several locations.

4. *Heat Island Mitigation Guidebook.* There is need for a guidebook on reducing heat islands. With support from the U. S. Environmental Protection Agency (EPA), the Electric Power Research Institute (EPRI), the California Institute for Energy Efficiency (CIEE), and UC/UERG (the University of California, Universitywide Energy Research Group), LBL is in the process of finalizing the first edition of this guidebook. Such a guidebook would be the best way to advise state or local government, or utility programs to start reducing heat islands. Support is needed for completion and continued updating of the guidebook.

5. *Demonstration and Monitoring.* After the manual, our next priority is to demonstrate the cost effectiveness of shading and painting school buildings in many cities. LADWP has already agreed to help us work with the Los Angeles Unified School District to shade and paint some portable "bungalow" schools, and measure the payback times. We will also lighten blacktop playgrounds, using chalk or some equivalent non-abrasive light colored material. The sooner we can compile a list of such experiments, the faster communities can be convinced to take part.

D. Funding

LBL has been doing heat islands research since 1985, supported by the University of California and by the California utilities. DOE has helped modestly (averaging $30,000/year) with technology transfer (workshops and cost-sharing an EPA Guidebook), but not with research. We believe that heat island mitigation is the single most cost effective and environmentally benign conservation measure that can be developed, and we suggest that DOE be funded to set up a new Institute for Urban Microclimate Management, co-sponsored by EPA, the Department of Agriculture, National Aeronautics and Space Administration (NASA), and the Electric Power Research Institute (EPRI), with an annual budget of $5 million. Since most of the major cities of the world are hot and smoggy in the summer, many countries should be interested in participating.

V. TECHNOLOGY IN SUPPORT OF INTEGRATED RESEARCH PLANNING

Integrated Resource Planning (IRP - formerly called Least Cost Utility Planning) has been one of the greatest recent advances in U.S. state energy efficiency programs, particularly in those states in the Northeast and West Coast where utilities have been permitted to retain for their stockholders 5-20% of the societal net savings resulting from their investments. Mirroring the success of utility adoption of IRP is the growth and success of DOE's IRP program.

In his statement at this hearing, entitled "Federal Actions to Improve Efficiency of Electricity Use," Dr. Eric Hirst outlines the studies which the DOE IRP program could undertake, and other actions which the Federal Government could pursue.

I support all of Hirst's statement, but want to go farther. Most utilities now support Demand Side Management (DSM) programs which total about $2 billion/year (1% of electric sales) and will probably grow to $5 billion/year. However, utilities are in need of much more help from DOE than can be offered simply by paper studies. Not only do utilities need these resources to plan and evaluate programs, but, if they are to earn a profit on their investment, they need hard information on the societal savings achieved by their programs.

Hirst estimates that by 2010, DSM programs will cut electric bills by $61 billion/year. There will also be savings from programs of gas utilities, so we are discussing about $100 billion/year. If utilities earn 10% on these savings, they will earn $10 billion/year. There should be good protocols and equipment for monitoring these savings, and now is the time to get started. This calls for a $10 million/year increase in DOE's IRP Program.

A. IRP Initiatives Cost-Shared with Other DOE Offices, Other Agencies, and Utilities

The following IRP initiative are the most general ones, where at least one other agency is involved, usually EPA.

1. *Energy and Emissions Audit & Diagnostic Centers--EEADCs.* Industrial Programs developed, and the Office of Financial and Technical Assistance (OFTA) now supports, EADCs (Energy Audit & Diagnostic Centers--no emissions) at mechanical engineering departments. This is a very successful program, but the same team of students and a professor who do the energy audits should also recommend steps to reduce emissions. This center would naturally collaborate with EPA. In California, utilities that give industrial audits to save energy are eager to expand to include emissions. Southern California Gas has offered $100,000 for a pilot project through the California Institute for Energy Efficiency (CIEE). IRP could co-sponsor this project and easily get cost sharing from utilities around the U.S.

2. *Mitigating Summer Heat Islands to Save Power (DOE) and Smog (EPA).* The case for mitigation of heat islands has already been made in this testimony. However, I will discuss why the IRP program should cost share heat islands research, rather than leave it to the Office of Buildings Technology (OBT).

   Most utilities now realize that about 10% of their peak power demand is associated with summer heat islands and that trees may have some benign effect, so many utilities offer tree-planting programs. However, they do not address light-colored surfaces, which are more cost-effective, because they are not aware of their added benefits. Also, nobody knows the relative cost-effectiveness of vines vs. trees. Thus, their programs are not optimized.

   If the new profit rules for utilities sweep the U.S. so that they earn about 10% of avoided net societal costs, and if the avoided heat island air conditioning costs run $1 billion/year, then utilities will be applying for earnings of $100 million/year. Clearly such large retained profits cannot be justified by the present research results, which are mainly paper studies. It is then urgent to do more experiments to establish the benefit/cost ratio of lightening the color of cities and of planting shade trees, vines, street trees, etc.

   Within DOE, then, this research is relevant to IRP and to buildings. The demonstration and technology transfer is of interest to OFTA and the Federal Energy Management Program (FEMP).

B. Collaborations Within DOE

1. DSM Technology Inventory and Analysis Centers and National End-Use Energy and Analysis Centers. New energy-saving technologies are constantly being incorporated in new buildings and equipment. It is vital to maintain an up-to-date assessment of these innovations and to determine if their measured energy use in the field matches predictions. A federally-sponsored program is necessary due to the diverse sources of the measured data and the need for an impartial analysis. This information will assist utilities, weatherization agencies, and individuals in selecting the most reliable and cost-effective efficiency improvements. DOE's Energy Information Administration (EIA) could be the central data repository, with data being supplied by the respective DOE end-use offices. The EIA and the National Laboratories could perform analyses to achieve these objectives.

Regional centers at the DOE operations offices could be established to provide "wholesale" advice to large conservation programs and projects in their respective areas. At the same time, more specialized consultation services would be available from Building Energy Technology Applications Assistance Centers located at National Laboratories. Under the California Collaborative Process, the utilities have already agreed to fund a DSM inventory, which could be one of the regional centers of a national inventory and analysis center. My understanding is that EPRI would gladly collaborate.

2. *Field-Testing of New Products and Technologies.* Test centers to field test new products and technologies before they are adopted by utilities could be Federal Buildings (via FEMP) or through individual utilities, as in the $10 million Pacific Gas and Electric (PG&E) Advanced Customer Technology test for Maximum Energy Efficiency (ACT^2) Program. Examples of new technologies which need more testing and fine-tuning are thermal storage, daylighting, super-high efficiency air conditioners, and occupancy sensors. Appropriate co-sponsors within DOE are the offices which developed the technologies.

3. *Selecting the Next Golden Carrot.* Under the leadership of PG&E, we will soon have a utility pool of some tens of millions of dollars which they can use as incentives to manufacturers to develop the next generation of refrigerators. The utilities will probably offer rebates of about $200 for the first 100,000 units which exceed the 1993 standards by 20 or 30%. This will accelerate the manufacture of a product which will not only save money for society, but will help our competitiveness. The idea should not end with refrigerators. DOE, with its experience in analysis for the appliance standards, should analyze all the major appliances to see which ones are most "ripe" for the second and subsequent Golden Carrot incentives. It should also study new, hybrid appliances. The program would be joint with OBT (Appliance and Equipment) and industry.

4. *DOE-3 and Advanced Energy Design and Operation Tool (AEDOT) Development.* All the building standards in the U.S. (and some other countries) are based on a program initiated by ERDA and completed years ago by DOE, called DOE-2. It is old, user-hostile, and difficult to update. Now, under the New England and West Coast conservation renaissance, utilities are spending hundreds of millions of dollars annually on advanced buildings, which will exceed existing standards and earn profits for the utilities. DOE-2 is simply not up to the job, so states like California are spending state money to test and approve simpler, friendlier programs. However, these simpler programs do not incorporate advanced technologies necessary to "beat" standards, so we have a problem that can only get worse.

   OBT supports the next generation of simulation, called DOE-3, very modestly. DOE-3 will be user-friendly, run under Unix on modern computers, and give the user the option of quick algorithms appropriate to conceptual design, to be replaced later by detailed algorithms for sizing equipment and thermal storage. But at the present modest rate of support, completion will take many years. Accordingly, the California Energy Commission (CEC) is interested in co-sponsoring DOE-3, and California utilities would likely throw in support via CIEE.

5. *Utility-Customer Communication, Computation, and Control (UC-3C).* Soon U.S. utilities will offer universal time-of-use rates, and perhaps even spot pricing of electricity. The Office of Utility Technology (OUT) Energy Management program is concerned with advancing this effort as far as the customer's meter but has not yet planned to exploit the huge potential savings on the demand side of the meter. For example, air-conditioner controls sould change so that temperatures are automatically set up when prices are high; during emergencies refrigerators and freezers could cycle off for 10 minutes (this is far cheaper than maintaining spinning reserve power plants), and thermal storage control algorithms can improve. Thermal storage will become of interest to builders of apartments and even homes. Right now, there is no economic motivation to the residential ratepayer who pays only time-average prices for electricity.

   UC-3C will address these demand-side controls. In addition to OUT's Energy Management Program, co-sponsors of UC-3C should be OBT and IRP, with help from EPRI, CIEE, and perhaps individual utilities, such as PG&E which has already expressed an interest.

C. New Topics Internal to IRP

1. *Initiate an IRP education program.* Such a program, administered through NARUC or a new non-profit entity, could educate new commissioners and provide technical assistance to PUCs contemplating IRP with profit incentives. Costs could be shared with EPA, the Energy Foundation, and other foundations.

2. *Initiate a program to monitor the performance of new buildings and the performance and persistence of retrofits in existing buildings.* Soon U.S. utilities will be earning hundreds of millions of dollars annually, based on estimated net societal savings from efficiency investments. In California, the PUC will permit engineering estimates for the first year or so, then measurements will be required.

   There can be large economies of scale if IRP will develop the protocols and the data collection systems. They are partly done already, thanks to the Texas Loan Star program. An advantage to a common system is that the PUC staff in one state would have to learn to check on only one instead of dozens of protocols and procedures. Sponsors could be OBT, EPRI, CIEE, and individual utilities.

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April, 1991

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1944	B.S., Physics, V.P.I., Blacksburg, VA
1954	Ph.D., Physics, University of Chicago Research Associate, University of Chicago
1955	Research Associate, Lawrence Berkeley Laboratory, Berkeley, CA
1957	Assistant Professor, University of California, Berkeley
1960	Associate Professor, University of California, Berkeley
1963-	Professor of Physics, University of California, Berkeley
1964-75	Director, Particle Data Group, Lawrence Berkeley Laboratory
1971-73	Leader, Particle Physics Research Group A, Lawrence Berkeley Laboratory
1975-86	Leader, Energy-Efficient Buildings Research Program, Lawrence Berkeley Laboratory
1978	Visiting Professor, College de France, Paris
1978-83	Vice Chairman, Energy & Resources Graduate Program, UC Berkeley
1983-89	Member of Energy & Resources Group Executive Committee, UC Berkeley
1983	D.Sc. (Honorary), University of Durham, England
1986-	Director, Center for Building Science, Lawrence Berkeley Laboratory
1988-90	Founder and Acting Director, California Institute for Energy Efficiency, a branch of the University-Wide Energy Research Group, University of California
1990-	Research Board Member, California Institute for Energy Efficiency

Publications: 300+ papers and review articles on particle physics, uses of computers, data processing, arms control, physics manpower, energy utilization.

Books:

Nuclear Physics, E. Fermi, J. Orear, A. Rosenfeld, R. Schluter; Chicago, 1949.

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Energy Sources: Conservation and Renewables, AIP Conference Proceedings No. 135, 1985. A. H. Rosenfeld: Chapter 6 (Residential Energy Efficiency: Progress Since 1973 and Future Potential); Chapter 8, with D. Hafemeister (Energy Conservation in Large Buildings); and Introduction to Chapter 20 (Managing Electricity Through Dynamic Pricing).

Editorial:

1964-73	Associate Editor, Journal of Computational Physics
1979-	Associate Editor, Energy and Buildings
1985-	Associate Editor, Energy, the International Journal

Panels, Committees & Awards:

1962-65	Committee on Uses of Computers, NAS
1963-66	Panel on University Computing Facility, NSF (Panel Chairman: '65-'66)
1964-72	Council Member, Federation of American Scientists (also '77-'81, '83-'87, '89-)
1967-69	Subpanel B, High Energy Physics Advisory Panel to AEC
1970-72	Statistical Data Panel, Physics Survey Committee, NAS
1977-	Energy Committee, Federation of American Scientists
1979	Co-founder, American Council for an Energy-Efficient Economy
1981-	Chairman ('81-'83) and President ('84-'90), Board Member ('90-), American Council for an Energy-Efficient Economy
1981-82	Governing Board, National Community Energy Management Center
1986	Leo Szilard Award of the American Physical Society for Physics in the Public Interest
1989-91	Mitigation Panel, Panel on Policy Implications of Greenhouse Warming; Committee on Science, Engineering, and Public Policy; National Academy of Sciences
1990-91	Technical Advisory Panel, Joint Committee on Energy Regulation and the Environment, California Legislature

American Physical Society, American Institute of Physics:

1967-71	Secretary/Treasurer, Division of Particles & Fields, APS
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1972-73	Committee on Economic Concerns, APS
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1978-83	Vice Chairman, Energy & Resources Graduate Program, UC Berkeley
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1970-72	Statistical Data Panel, Physics Survey Committee, NAS
1977-	Energy Committee, Federation of American Scientists
1979	Co-founder, American Council for an Energy-Efficient Economy
1981-	Chairman ('81-'83) and President ('84-'90), Board Member ('90-), American Council for an Energy-Efficient Economy
1981-82	Governing Board, National Community Energy Management Center
1986	Leo Szilard Award of the American Physical Society for Physics in the Public Interest
1989-91	Mitigation Panel, Panel on Policy Implications of Greenhouse Warming; Committee on Science, Engineering, and Public Policy; National Academy of Sciences
1990-91	Technical Advisory Panel, Joint Committee on Energy Regulation and the Environment, California Legislature

American Physical Society, American Institute of Physics:

1967-71	Secretary/Treasurer, Division of Particles & Fields, APS
1969-71	Physics Information Committee, AIP
1972-73	Committee on Economic Concerns, APS
1974-77	Governing Board, AIP
1976-79	Panel on Public Affairs, APS
1977-79	Forum on Physics and Society, APS

Principle Investigator other than AEC/ERDA/DOE:

1970-72	NSF Computing Facilities Grant to Lawrence Hall of Science
1971-77	NSF Grant to Particle Data Group, Berkeley

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Mr. **Scheuer**. I don't want to get into questions now, but the market may do that in the private sector, but when it comes to Federal buildings, the market can't do it. Only Federal decisionmakers can do it. One comes head up against the question, Why aren't they doing it?

Dr. **Rosenfeld**. Well——

Mr. **Scheuer**. Why don't you answer that later? I'm really imposing upon the other members of the panel and my colleagues up here.

Dr. **Rosenfeld**. Okay. Sure.

Mr. **Scheuer**. But we will ask you, Why isn't the Federal Government moving in this direction with this incredible cost/benefit pay-out?

With apologies, Dr. Marc Ross?

Dr. Marc Ross is professor in the physics department of the University of Michigan at Ann Arbor.

Please proceed, Dr. Ross.

STATEMENT OF DR. MARC ROSS, PROFESSOR, DEPARTMENT OF PHYSICS, UNIVERSITY OF MICHIGAN, ANN ARBOR, MI

Dr. **Ross**. Thank you.

I'm addressing transportation and industrial areas. I will mostly talk about automobiles, an industry which we hope in Michigan is not actually dying.

The opportunity is really very great for new technology. There have been a variety of discussions this morning about how much we might be able to do with the current technology. A lot of people talk about that. But I want to talk about new technology to make the progress that we all want to make much more feasible.

More development projects are needed—and I'm going to give some examples—and also what is needed is more research on base technologies, which I hope to explain. That kind of research, as distinguished from development, is represented by some current programs—the combustion research program, which is supported in the industrial office, and the ceramics research, which is supported in the transportation office—a lot more of those things are needed. I want to give some examples.

One example is improving the internal combustion engine. Half of the fuel use is to overcome friction, yet we don't have good tools for measuring and analyzing friction. We're sort of—to exaggerate a bit—back in the stone age, where today there could be extremely modern and effective measurement and analytical capabilities.

The private sector is loathe to undertake basic work of that kind. It would be hard for them to get the benefits of their research efforts as opposed to more particular development efforts are very limited. So we could do a great deal if we would just create a program, analogous to the combustion research program, in which we develop the measurement capabilities and analytical capabilities to study friction (or tribology).

A secondary is hybrid vehicles. I think we're all aware that the all-electric vehicle has the problem that it doesn't go very far in one day and to recharge takes perhaps hours. There are alternatives to make something like an electric vehicle work, and the main alternative is the hybrid vehicle where you still have a small fuel driven engine to give you the option of range. The hybrid vehicle management schemes—how you would integrate the use of batteries and a small fuel driven engine—are, it's amazing to find, unknown. We have not studied those management schemes. We do not know how you would design such a vehicle. The last work was done in the 1970s.

There are completely different kinds of vehicles that you might design. You might try to optimize by minimizing the use of a fuel engine. In a Los Angeles application, you might try to maximize the energy efficiency. We have a program in the Office of Transportation Technology which has the name hybrid in it, but there hasn't been any work done in that area for quite a long time.

Another alternative for hybrid vehicles, to overcome that range and recharging problem, is flywheels, a technology which—advanced flywheels have been looked at in the 1970s and a little bit by the military in the 1980s, but really it's a largely unexplored area in terms of modern capabilities. What you can do with a flywheel that you cannot do with a chemical battery—the flywheel I should say is an electromechanical battery. Think of it simply like a battery. You put energy in and you take it out. It is lighter than an ordinary battery. That's an important advantage. But the really critical advantage is the high power levels. You can put energy in at enormous rates and take it out at enormous rates. It turns out more important to a vehicle than the amount of energy you can store because we want to be able to exchange energy with the brakes, with a fuel engine, and we want to be able to recharge rapidly, and chemical batteries are extremely limited.

The modern flywheel concept is not necessarily an easy one—it's a risky one—but it is very promising, and there's nothing going on. It's too risky for private sector work.

Another example are technologies that both look promising from an energy efficiency standpoint and from an emissions reduction standpoint. So they are synergistic. One area is the cycle to cycle, as the engine turns over, there is a lot of variation in fuel use, fuel efficiency, and emissions with each cycle. We simply don't understand those variations and their control. We are not controlling them at present. The catalytic converter would work much better if we had a very even engine operation and so would the efficiency be higher.

There are fuel improvement issues, injection improvement, valve improvement, and emission improvement issues that might be learned about if we could do the research that would enable us to learn why there are these variations.

Another area is cold start—cold start of the engine when the engine is cold. We get a lot of emissions and we get inefficient operation. There are heat storage ideas so that from the previous operation of the engine yesterday or a couple days earlier, you could warm the engine. There is work going on in Germany on that, but as far as I'm aware, none in the United States.

There is work we can do on fully variable valves. We now have the so-called cam-driven valve in which the motion of the valve is exactly the same, no matter what the conditions of operation are. But through electricity—electronic management—we could manage the valve path entirely as it depends on the engine speed and power requirements, whether the engine is cold or not. We haven't explored what could be achieved with that kind of change. As you know, our manufacturers are loathe to open up these new possibilities because Congress might tell them, "Let's go ahead and do it." We have a hearing downstairs on the first floor on that kind of issue today.

So we have many areas—and I haven't mentioned industrial areas. I will just cite one example—cleaning in industry. We don't have the background to know how to do that mundane operation of degreasing without using carcinogens or chlorinated hydrocarbons and chlorinated fluorocarbons which damage the environment. We don't understand cleaning well enough in a basic sense. It's too mundane. Who would have studied it? Nobody is the answer.

So if we know more about new technology and the development of new technologies we will make a major step. As I think your remarks made clear, that's not going to be enough. Energy efficiency offers great promise, costs are lower, but it's not easy to achieve. I think people at this table today are talking about how we could move ahead with new technology, but we're not actually addressing how we get the private sector—or even more difficult, the General Services Administration—to move ahead with those new technologies after they have been created.

That is a tough one. I am not addressing it. I have to admit that.

[The prepared statement of Dr. Ross follows:]

Testimony on the Department of Energy's Budget Request for Energy Conservation (Offices of Transportation Technology and Industrial Technology)

before the
Subcommittee on Environment,
Committee on Science, Space and Technology
April 17, 1991

Marc Ross
Professor of Physics, University of Michigan,
Ann Arbor, Michigan 48109

(On Sabbatical at Lawrence Berkeley Laboratory)

I am grateful for the privilege of addressing this group. My subject is the R&D programs of the Offices of Transportation Technology (OTT) and Industrial Technology (OIT) within the Conservation and Renewables Office at the Department of Energy.

The development of new technology in the transportation and industrial-process areas from the perspective of energy and environment is very important. The opportunities for continuing to provide, at reasonable cost, the products and services we as a society want, but with much lower energy and environmental impacts--through new technology--is great. That much is clear. Unfortunately, even if excellent new technology is developed, it may not be rapidly or widely adopted. It cannot be claimed that effective R&D policies are enough. They are part of the policy approach needed, and it is that part we are addressing today.

The Need for Research On Base Technologies

The context in which these R&D programs operate is corporate, university and national (and private) laboratory research and development activities funded from sources outside DOE. The key fact is that in the mature, practical areas of technology that concern us here, ground transportation and manufacturing process technologies, research activity is very limited. (There are important exceptions, e.g., in the manufacture of organic chemicals and of computers.)

One may ask, "if the sectors are mature, why do we need research"? The answer is that even in mature areas, like automobiles or like manufacturing steel, the potential of research has been revolutionized by the scientific-technological revolution of recent decades, so there is a tremendous opportunity offered by re-examining these processes and technologies. DOE should take the lead in those areas which use most of our energy and create most of the pollution.

An important part of the opportunity lies in creating high-tech measurement and analysis capabilities so that we can routinely observe what is going on in harsh environments and in complex situations. This is the essence of the successful combustion research program now partly funded by OIT.

An indicator of the serious under-funding of research in these mature areas is the high impact that the DOE transportation program has had, even though it is modest in its research support. We hear a lot of complaining about funding from powerful academic researchers in major league fields like cancer and high-energy physics. The engineering fields I am discussing are not even in the minor leagues by comparison. The country is foolish not to provide significant support in these fields; little money need be involved.

Examples of Opportunities

Let me illustrate the opportunities with some examples. Some of the research areas needing a strong push in ground transportation are:

- engine friction
- hybrid engine schemes
- synergistic efficiency/emissions technologies

Engine friction is an old topic. The potential for creating new laboratory capabilities are great. We can now develop the tools to really measure friction. For example, we can measure how it depends on load so we can address the opportunities to reduce friction at the relatively low loads where automotive engines typically operate. This is an important and relatively neglected area. Friction reduction in all its forms offers as good an opportunity for fuel economy improvement as weight reduction, in my opinion.

Hybrid engines combine an ordinary engine and energy storage with sophisticated system management. Storage is a tough challenge which should be addressed by study of both electrochemistry (batteries) and of mechanical systems (fly wheels, fluid under pressure). Some basic work on electrochemistry is being supported. Basic study of mechanical storage systems is needed.

Technologies that could benefit both fuel economy and emissions reduction should be strongly pursued. Two examples are

1) controlling the cycle-to-cycle variation in engine output, and 2) the performance of engines and emission control when cold and the role of fast warm-up. There are base technology research needs; some development projects might also be pursued.

The possibilities in manufacturing processes tell a similar story, although, the opportunities and needs are far more varied. One example is provided by steel. There is a "steel initiative", or metals initiative, which has been supported by Congress and is managed by OIT. This is a development program in a context of almost no research. That is not a good mix.

Industrial cleaning or degreasing is another example, one I'm especially fond of because it is so mundane. The area is important because such cleaning is now widely accomplished with chlorinated hydrocarbons, many of which are carcinogens. Research on the fundamentals of cleaning is needed: for example, research on the effects of ultrasonics, electromagnetic radiation, thermal shock, and specially designed surface materials on the adhesion of impurities to surfaces.

Another example is provided by recycling. Here, the paradigm should be the aluminum beverage can: recycling a product into the same high value product. Unfortunately most recycling uses the material in a lower value application, often much lower. As a result, markets for recycled material are often poor. Research is needed on all phases: the original product design, separation of recycled material, and reuse in the manufacturing process, in order to help understand and achieve goals for recycling into high value products.

As mentioned, the industrial sector is highly varied. These examples are only a small indication of the opportunity.

Comparison with Present Programs

How does this discussion relate to the present programs?

The transportation program has an element along these lines: their work on transportation materials. The rest of the program is development work on particular projects in selected areas: gas turbines, low-heat-reduction diesels for trucks, electric vehicles, and alternative fuels. I am very pleased to see the new projects on hybrid engines and fuel cells.

What is needed is of two kinds: First, the most promising development programs need to be expanded, fuel cells and hybrid engines, including development of products related to hydrogen as a fuel. Second, base technology research programs should be created in areas like those suggested above.

The OIT program also has a part which addresses some of the concerns I've expressed: the modest "Advanced Industrial Concepts" program element. An important part of this is partial support for the Combustion Research Facility at Sandia Livermore Laboratory. This basic work on combustion is helping to provide a basis for a wide variety of public and private development efforts. The general approach of research on base technologies as a complement to specific development projects needs to be strengthened, as suggested above. Additional base technologies, analogous to combustion should be identified and programs planned. Aspects of separations probably merit several programs of which cleaning, mentioned above, is one. (I suppose it will have to be called "advanced cleaning.") The various mature energy-intensive production processes like paper, cement, glass, and iron and steel merit such programs. In steel, for example, separate research programs in smelting (the hot end) and shaping are needed.

Having emphasized this concept of supporting research and, where appropriate, research centers or sophisticated user-oriented research facilities, let us turn to a different kind of need: for the small and medium-sized firm in adopting already developed production-process technologies. Expansion of the modest but useful Energy Analysis and Diagnostic Center program is proposed and is desirable. More ambitious specialized outreach activities should also be developed and supported in areas of energy-intensive technology like variable speed drive and welding/joining.

In summary, there should be a major expansion for activities in these two offices, both in funding and in type of activity. Although I am an enthusiast for conservation technology, I also recommend that the expansion be gradual.

Marc Ross

Marc Ross is professor of physics at the University of Michigan and senior scientist in the Energy and Environmental Systems Division, Argonne National Laboratory. He obtained his PhD in physics at the University of Wisconsin in 1952. He worked in theory of fundamental particles, primarily at Indiana University and Michigan, until 1972 when his interests shifted to energy and environmental problems. He co-directed the American Physical Society's study of efficient energy use in 1974. His research concerns the technology and economics of energy use. Major activities in the early 1980s were work on the Mellon Institute's project on Industrial Energy Productivity and on the Alliance to Save Energy's project on Industrial Investment in Energy Efficiency. A book on energy policy, Our Energy: Regaining Control, written with Robert H. Williams of Princeton University, was published by McGraw Hill in 1981. More recently he has worked on issues of technology and energy demand for the Office of Technology Assessment of the U.S. Congress and the American Council for an Energy Efficient Economy. Professor Ross' current research at the University focuses on energy and environmental implications of transportation.

Mr. SCHEUER. Thank you, Dr. Ross.

Dr. Eric Hirst, from the Oak Ridge National Lab in Oak Ridge, Tennessee?

Please proceed, Dr. Hirst.

STATEMENT OF DR. ERIC HIRST, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TN

Dr. HIRST. The latest annual report from New England Electric contains a remarkable statement in its letter to shareholders. "Our energy conservation programs continue to lead the Nation and contributed more than $4 million to pre-tax earnings."

New England Electric plans to cut electricity use among its customers by 7 percent by the year 2000 and this year is spending $85 million on its demand side management programs, more than triple what it spent just 3 years ago.

The challenge to this Subcommittee and to the Department of Energy is to encourage other utilities, both electric and gas, to take the same kinds of ambitious and productive actions that New England is taking. Federal leadership in this area is important because electric utilities account for almost 40 percent of the Nation's primary energy consumption. That fraction is growing steadily year after year.

In addition, as you pointed out before, and as Chuck Guinn did, electric utilities account for major shares of national pollutants. For example, one-third of the total carbon dioxide emissions in the U.S. come from electric utilities.

Also public opinion supports improving energy efficiency. A survey late last year asked adults about their preferred way to meet increasing demand for electricity—28 percent favored "build new power plants," but 66 percent favored "more efficient use of electricity." So almost two-thirds of the respondents wanted to see their utilities do more to improve efficiency of electricity use. Unfortunately, only 13 percent of those respondents rated their local electric utility as doing an excellent job of promoting energy efficiency.

So what should the role of the Federal Government be, given this tremendous opportunity? The opportunity arises because the Federal Government can work with a few hundred utilities and through those utilities affect the energy-related actions of tens of millions of households and millions of businesses and manufacturers.

There are a number of things the Federal Government can do. DOE can expand its integrated resource planning program—I will say a little bit about that in a minute—the Federal Regulatory Commission should revise the way it reviews wholesale power contracts to take explicit consideration of energy efficiency, load management, and renewable resource programs. The Federal utilities—the Tennessee Valley Authority and the power marketing agencies—ought to adopt integrated resource planning and demand-side management programs. That is consistent with your points, Mr. Chairman, about what the Federal Government itself should be doing.

It turns out that these Federal utilities sell electricity in 32 States in the country. So what they do not only affects millions of customers, but also can have a very important catalytic in technology transfer activity.

The Internal Revenue Service ought to repeal its rule that treats as taxable income utility incentives to customers for purchase of energy-efficient equipment. And, finally, the Energy Information Administration ought to increase the amount of data it collects and analyzes on energy use, energy efficiency, and utility demand-side programs.

My testimony covers all these points. I would like to just mention one of these areas, the DOE Integrated Resource Planning Program. This is a very small program that has been in operation now for 5 years and has worked closely with regulators and utilities, primarily on projects related to technical assistance and technology transfer so that the successes in New York and California can be made available to utilities and regulatory commissions in other States.

The program was started in 1986 with an annual budget of $1 million a year. This year it is $3 million and DOE has requested $5 million for fiscal year 1992. This is very small. When you compare it to the size of the utility industry, which is $160 billion a year, it's absolutely minuscule. I agree with Howard Geller, as reflected in the alternative energy conservation budget, that the budget for the Integrated Resource Planning Program ought to increase.

Let me give three small examples of the kinds of successes that this $1 million a year program has already had. Through the National Association of Regulatory Utility Commissioners, DOE funded three national conferences on integrated resource planning—one in 1988, one in 1989, and one that was held just last month. These have been wonderful conferences because they bring together people from all constituencies—utilities, regulators, environmental groups, consumer groups, national laboratories, and so on.

While one measure of success of these conferences—attendance has more than doubled between the first and the third conference. There were over 400 people in Santa Fe, New Mexico at the conference last month.

DOE sponsored a preparation of a study that culminated in a report at the end of 1989 on financial incentives to utility shareholders for cost effective DSM programs. Chuck Guinn, in talking about New York, mentioned how the utilities are aggressively pursuing energy efficiency because of these incentives. The statement I quoted from New England Electric also talked about the money that comes to shareholders because of these programs. It's a very important regulatory reform that has largely been stimulated by DOE action.

And finally, we at Oak Ridge National Laboratory reviewed 30 plans prepared by utilities across the country and used that review of these plans to form recommendations to utilities on how to prepare long-term resource plans and to regulatory commissions on how they ought to review the plans.

As I mentioned, my testimony has other material on what the Federal utilities should do, the IRS rule, FERC regulation of wholesale contracts, and expansion of EIA's data collection activity, but I won't go into that now.

Let me conclude by saying that if DOE and the States and the utilities work together and expand utility DSM programs, I believe that these programs could cut electricity use by the year 2010 by as much as one-fifth. That would save customers $61 billion a year in reduced electric bills; it would improve environmental quality; it would improve economic competitiveness; it would eliminate the need to build 400 medium sized power plants; and it would respond to public concerns.

The Federal role in this area is vital. It's catalytic rather than regulatory because it provides technical support and information transfer. As a consequence, it's very inexpensive to the U.S. taxpayer.

Thank you.

[The prepared statement of Dr. Hirst follows:]

FEDERAL ACTIONS TO IMPROVE EFFICIENCY OF ELECTRICITY USE

Statement of
Eric Hirst
Energy Division
Oak Ridge National Laboratory[*]
Oak Ridge, Tennessee 37831

Before the
Subcommittee on Environment
Committee on Science, Space, and Technology
U.S. House of Representatives
Washington, DC 20515

April 17, 1991

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[*] Operated by Martin Marietta Energy Systems, Inc. under contract No. DE-AC05-840R21400 with the U.S. Department of Energy.

Mr. Chairman and Members of the Subcommittee, the Federal Government, working with electric utilities, can substantially improve efficiency of electricity use in the U.S. Electric utilities account for almost 40% of the nation's primary energy consumption. Further, electricity production is capital intensive and environmentally damaging. Therefore, improving the efficiency with which customers use electricity not only saves money but also provides substantial indirect benefits. The U.S. Department of Energy (DOE) can work with utilities to ensure that these large energy-efficiency benefits are realized. Because the federal role with respect to utilities is primarily catalytic, the cost to the U.S. taxpayer of these DOE activities is small.

RECENT PROGRESS

During the past several years, utilities have increasingly turned to programs that affect the efficiency and timing of customer electricity use, called demand-side management (DSM) programs. Such program might include promotion of new lighting systems in office buildings, efficient appliances in homes, and adjustable-speed drives for industrial motors; and direct control of electricity-intensive equipment such as air conditioners at certain critical times. Such energy-efficiency and load-management efforts can:

Provide low-cost alternatives to construction of new power plants;
Save money for customers;
Improve relations with customers by providing additional services;
Improve relations with state public utility commissions (PUCs);
Reduce financial risks to utilities;
Improve environmental quality; and
Enhance the economic competitiveness of utilities and their customers.

Utilities in the northeast, upper midwest, and west coast are expanding greatly the number and scope of their DSM programs. Table 1 shows the current plans of some leading-edge utilities to improve efficiency of electricity use during this decade.

These ambitious programs and plans are stimulated by several factors:

- Growing interest in integrated resource planning (IRP), which involves explicit consideration of DSM programs as cost-effective alternatives to some new power plants

- Increasing concern about the environmental effects of electricity production and transmission, especially global warming and acid rain

- Provision of financial incentives to utility shareholders for implementing cost-effective DSM programs

- Growing recognition of the powerful role that utilities can play in overcoming market barriers to adoption of cost-effective energy-efficiency opportunities

Table 1. Sample of utilities with ambitious energy-efficiency programs

Utility (state)	Projected reduction in year 2000 electricity use caused by utility DSM programs (%)
Southern California Edison (CA)	13.0
Taunton Municipal (MA)	11.1
Long Island Lighting Company (NY)	9.0
Consolidated Edison (NY)	8.1
Seattle City Light (WA)	7.0
Northeast Utilities (CT, MA)	7.0
Puget Power (WA)	6.8
New England Electric (MA, NH, RI)	6.6
Wisconsin Electric Power (WI)	6.2
Pacific Gas & Electric (CA)	6.0

Source: Hirst (1991).

These changing trends are dramatically increasing the efforts of some utilities. For example, the planned 1991 budgets for DSM programs in California increased by about 50% between 1989 and 1990. These increases were largely a result of an extensive collaborative process, one outcome of which was provision of financial incentives to the California utilities for their DSM programs. A similar situation is occurring in New York state; utility DSM expenditures are increasing rapidly, from $105 million in 1990 to $168 million in 1991, and $195 million in 1992.

FEDERAL ACTIONS TO ENCOURAGE UTILITY DSM PROGRAMS

Because electricity production consumes a large and growing percentage of the primary energy used in the U.S., electricity must be a major part of national energy policy. In addition, national concerns about environmental quality, economic productivity, international competitiveness, and national security suggest a larger role for the Federal Government in working with utilities to implement DSM programs. Traditionally, state PUCs have had the largest effect on the activities, finances, and prices of utilities. Until passage of the 1978 Public Utility Regulatory Policies Act, the Federal Government exerted only limited influence over utility activities. In recent years, DOE's interactions with utilities on energy-efficiency have included cosponsorship of conferences and collaboration on a variety of projects, primarily through DOE's Integrated Resource Planning Program (U.S. Department of Energy 1990).

Improving energy efficiency through electric utilities is a particularly effective way to reach energy consumers. Utilities have direct monthly contact with all their customers through meter reading and billing. Utilities have long-standing and generally good relationships with their customers and with the communities they serve. Utilities are widely recognized for their technical competence. Utilities have large field organizations that can deliver DSM programs to customers. Utilities have ready access to capital, leading to a low cost of capital and steady cash flows. All these factors make it easier and more efficient for utilities than for other organizations to design and implement DSM programs. Thus, the Federal Government can work with a few hundred utilities and, through them, reach tens of millions of households and millions of businesses.

DOE's *National Energy Strategy* recognizes the importance of electricity to the nation's energy future and the powerful role that electric utilities play in shaping that future. The chapter on "Electricity Generation and Use" emphasizes integrated resource planning, and the roles of the Federal Power Marketing Administrations (PMAs) and the Federal Energy Regulatory Commission (FERC) in encouraging IRP. My testimony supports these elements of the *National Energy Strategy* and suggests additional DOE activities to strengthen utility DSM programs. These suggestions, discussed below, include extension of IRP to gas utilities, and collection by the Energy Information Administration (EIA) of additional data on energy consumption and on utility DSM programs.

The *National Energy Efficiency Act of 1991*, recently introduced in the U.S. House of Representatives (1991), addresses some of these issues. Title III (Electricity and Utilities) encourages regulatory consideration of the financial impacts on utilities of running DSM programs, encourages nonregulated utilities to acquire cost-effective energy-efficiency resources, and requires the PMAs to assist their utility customers to implement DSM programs. And Title VI (Miscellaneous) requires EIA to publish information on energy use on a state-by-state basis and to collect information on electric-utility DSM programs.

EXPAND DOE's INTEGRATED RESOURCE PLANNING PROGRAM

The DOE IRP program was established in FY-1986. For several years its annual budget was about $1 million. The budget for this year is $3 million and the DOE request for FY-1992 is $5 million. By comparison, the nation's annual electric bill is $160 billion and electric utilities currently spend about $2 billion annually on their DSM programs. Because of its small budget, the DOE program works closely with other organizations and focuses on cost-sharing cooperative projects, with DOE assistance provided through the national laboratories and other contractors.

The DOE IRP Program seeks to:

- Improve the processes used to plan for future resource acquisitions, including data, computer models, organizational approaches, treatment of uncertainty, and consideration of a wide array of alternative resources
- Develop data and analytical tools to ensure that energy-efficiency, load-management, transmission and distribution, and renewable-energy technologies and programs are fully considered by utilities and their regulators in resource planning and acquisition
- Cosponsor field demonstrations of promising planning methods, DSM technologies and programs, and renewable resources
- Develop methods to encourage nonutility participation in resource planning, including workshops, advisory committees, and collaboratives
- Examine the indirect effects (especially on environmental quality) of alternative electricity and natural gas supply and demand resources
- Examine alternative state and federal regulatory approaches to improve utility resource planning, including revisions to the Public Utility Regulatory Policies Act and the Public Utility Holding Company Act, implementation of the 1990 amendments to the Clean Air Act, and provision of financial incentives to utilities for acquiring cost-effective DSM and renewable resources
- Improve the flow of information among utilities, state and federal regulators, other government agencies, and other groups interested in utility resource planning
- Assess alternative ways to acquire resources, including bidding for demand and supply resources
- Assess appropriate activities by DOE to promote IRP, including the roles of FERC and the PMAs

The underlying rationale for much of the DOE activities is the knowledge that many innovative and successful programs operate throughout the country. However, information on these successes is hard to obtain because the sponsoring utility and/or state agency has little incentive to publish information on the program. Thus, DOE can play a valuable technology-transfer role by participating in these programs, ensuring that the programs are carefully evaluated, and then funding preparation of reports and conference presentations that effectively and widely disseminate information to other utilities and state agencies. The Northeast Region Demand-Side Management Data Exchange (NORDAX), funded in part by DOE, is a good example of such technology transfer. The initial phase of NORDAX, a consortium of more than 20 utilities, yielded a data base with information on 90 DSM programs operated by 17 utilities (Berry and Hirst 1989). Since NORDAX began in 1987, it has expanded, in both membership and data on utility DSM programs.

Key ares in which the DOE program could expand, given additional funds, are:

- Work with "leading edge" utilities and commissions on emerging IRP issues. These issues include provision of financial incentives to utilities for operating cost-effective DSM programs; development of methods to evaluate DSM programs; collection and dissemination of data on DSM technologies and programs and on renewable resources; development of improved computer models for resource planning; use of collaborative processes to reach agreement on what would otherwise be contentious (and therefore litigated) issues; and inclusion of environmental factors in resource planning.

- Extend IRP principles and practices to regions of the country that are not yet active. In particular, the southeast, southwest, and much of the midwest and west could benefit from the experiences gained in other parts of the United States.

- Extend resource planning and management activities from electric to gas utilities. Although gas and electric utilities differ in vertical integration, mix of federal and state regulation, and planning horizons, many of the lessons learned in electric-utility planning and resource acquisition apply to gas utilities (Hirst, Goldman, and Hopkins 1991).

- Increase regional planning. Although electricity is sold and regulated primarily by companies and commissions operating within state borders, planning issues are often regional in scope. For example, many utilities belong to tightly coupled power pools. Utilities in the four-state Pacific Northwest are affected by the actions of the Bonneville Power Administration and the planning decisions of the Northwest Power Planning Council. Several holding companies produce and sell electricity in several states. And all utilities belong to one of the regional reliability councils of the North American Electric Reliability Council. These organizations and activities suggest the need for additional regional coordination, both among utilities and among the government agencies that regulate them.

REQUIRE UTILITY WHOLESALE CONTRACTS TO INCORPORATE DSM PROGRAMS

The Federal Energy Regulatory Commission (FERC) approves all wholesale transactions among utilities. Currently, FERC reviews of proposed contracts involve no consideration of energy efficiency. FERC could require the buying utility to demonstrate that it has acquired all the conservation and load-management resources in its service area that cost less than the proposed purchased power before FERC approves the contract.

Consider, for example, a proposed 10-year contract for purchase of baseload power at a cost of 6¢/kWh. The purchasing utility would have to include documentation in its application to FERC showing its plans to acquire all the end-use efficiency improvements available in its service area at a total cost (including the utility's administrative costs) of less than 6¢/kWh. Similar requirements for load-management programs would apply to purchases of peaking power. Presentation of an integrated resource plan, approved by the utility's PUC, could satisfy this requirement.

REQUIRE FEDERAL UTILITIES TO EXPAND DSM PROGRAMS

The federal PMAs (part of DOE) and the Tennessee Valley Authority (TVA, an independent federal corporation) account for almost one-tenth of the electricity consumed in the U.S. Traditionally, TVA and the Bonneville Power Administration (the largest PMA) have operated large DSM programs, programs that not only saved energy for their customers but also served as examples for other utilities. Unfortunately, short-term budget considerations forced substantial reductions in these programs. Indeed, TVA canceled all its conservation programs in 1989. Bonneville, on the other hand, plans to increase its conservation budgets over the next several years. Bonneville plans to spend $440 million to acquire nearly 1200 GWh/year between 1990 and 1993. This is in addition to the 2100 GWh/year acquired between 1981 and 1988.

The Western Area Power Administration (1986), the second largest PMA, runs a small Conservation and Renewable Energy Program for its 800 utilities. Western's service area encompasses 15 western states, a region of the country which, except for California, has little integrated resource planning and few DSM programs. As a consequence, Western's program could have large "technology transfer" benefits throughout the region.

Western's current program emphasizes flexibility for its customer utilities, primarily because these utilities differ substantially in size, mix of customers, dependence on other producers for their electricity supplies, and load/resource balance. Because of this diversity, Western imposes few requirements on its customers, operates a decentralized program from its five regional offices, and offers extensive technical assistance. Depending on the size and type of utility, it is required to conduct from one to five "activities," chosen from a list of approved projects developed by Western.

Western is revising the program, with a final rule expected to be issued in mid-1991. Western could set aside a fraction of its low-cost federal hydropower for assignment to those utilities that run especially effective programs. Access to additional low-cost power would be a very effective way to encourage utilities to pursue aggressively cost-effective DSM programs. Alternatively, Western could purchase energy savings and load reductions achieved by its customer utilities.

New federal legislation could require the federal power authorities to expand their DSM programs and to consider explicitly environmental and social factors in their benefit/cost analyses of all resource alternatives. Such legislation would be a logical extension of the 1980 Pacific Northwest Electric Power Planning and Conservation Act (P.L. 96-501), which explicitly made conservation the electricity resource of choice. Even without new legislation, the PMAs could expand their DSM programs, as the Western and Southwestern Power Administrations already are.

The PMAs and TVA sell electricity in 32 states. Thus, these federal agencies can play a powerful role, working with utilities, state government agencies, and other organizations, to demonstrate the benefits of integrated resource planning and demand-side management programs. Even though the amount of power sold by the PMAs represents only a small fraction of that consumed in each PMA's service area (except for BPA and TVA), the PMAs could play important information transfer and technology demonstration roles in their regions.

COLLECT MORE INFORMATION ON DSM PROGRAMS AND ELECTRICITY USE

EIA is responsible for collecting, evaluating, analyzing, and disseminating information on energy reserves, production, demand, and technologies. The bulk of EIA's efforts are related to the supply of, rather than the demand for, energy. For example, EIA's (1990) *Annual Energy Review* contains eleven chapters, only one of which is on energy consumption.

EIA collects detailed information from electric utilities on individual power plants related to their construction cost and capacity; annual operations and maintenance expenses; and monthly fuel consumption, generation, availability, and air emissions. In late 1989, EIA added a section to its Form-861; this section requests information on the current and planned energy savings, load reductions, and costs of electric-utility DSM programs. Unfortunately, lack of time and staff prevented EIA from pretesting these questions. As a consequence, the utility responses were largely unusable and EIA decided not to publish results from this first nationwide survey of electric-utility DSM programs. Hopefully, the revised section (EIA 1991) will yield usable responses this year. EIA collects no comparable data about gas-utility DSM programs.

EIA conducts detailed energy end-use surveys of households, commercial buildings, and manufacturers. These surveys are conducted once every three years. (By comparison, EIA collects monthly data on all fuel sources and electricity.) The end-use surveys collect valuable information on the energy-related characteristics of the facility and its energy-using equipment and on the occupants. This information is then linked to a year of actual fuel-consumption data for the building or industrial plant.

Additional information on the patterns, trends, and determinants of energy use would be very helpful in designing and managing energy-efficiency programs. Such information might indicate whether and why consumers participate in various types of conservation programs, what factors influence their purchase of energy-using equipment, and what factors affect their operation and maintenance practices. And EIA could expand the data-collection forms completed by utilities to require information on their DSM programs. These activities would help to redress the substantial imbalance between the supply and demand sides in EIA's data-collection activities. In addition to expanding EIA's collection of data related to energy use and to DSM programs, EIA and DOE's Office of Conservation and Renewable Energy could devote more effort to analyzing these data to improve our understanding of energy-related behaviors in all sectors of the economy.

The *National Energy Strategy* emphasizes reliance on market forces to deal with energy use, using phrases such as "successful policy of market reliance" and "market driven." A crucial requirement for functioning markets is widely available, accurate, and credible information. If the nation is serious about relying on market forces to resolve energy problems, EIA must expand its demand-side data collection efforts.

CONCLUSIONS

Improving the efficiency with which electricity is used can save money for U.S. consumers, reduce the need to build new generation and transmission facilities, improve the financial performance of utilities, reduce emissions of greenhouse gases and other pollutants, improve economic productivity, and improve utilities' relations with their customers and regulators.

A recent ORNL study estimated that utility DSM programs could cut electricity use by one-fifth by the year 2010 (Hirst 1991). By the year 2010, these DSM programs would cut electric bills by $61 billion a year. In addition, total U.S. emissions of CO_2 would be cut by 9% that year relative to what they would have been without utility DSM programs. Finally, the electricity savings caused by these ambitious DSM programs represent almost half of the growth in electricity use between 1990 and 2010. In concrete terms, these programs could cut the need to build 430 medium (500-MW) power plants. Also, fewer transmission lines, distribution lines, substations, and transformers would need to be built.

Electric utilities, with the support of their public utility commissions, can play a vital role in realizing this large potential to save energy and cut peak demands. The Federal Government, working with a few hundred utilities, can influence the energy-efficiency actions of tens of millions of consumers. Useful federal activities include improved regulation of wholesale power transactions, expansion of DSM programs run by federal utilities, expansion of DOE's Integrated Resource Planning Program, and collection of more data on electricity use and on utility DSM programs. Fortunately, the federal actions proposed here require little additional funding and will therefore not worsen the federal deficit.

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Mr. Scheuer. Thank you.

Mr. Wolpe?

Mr. Wolpe. Thank you very much, Mr. Chairman.

Let me express my appreciation, first of all, to the panelists for excellent testimony. It is nice to begin to return to the kind of discussion we were having over a decade ago that yielded such dramatic progress, at least within that span of time.

I would like to ask some questions that go to kind of ball park kinds of projections of what is still achievable by appropriate investments in efficiencies.

The NES, National Energy Strategy, had a projection as it related to the electricity sector that the implementation of this strategy was expected to reduce the demand for fuels used to generate electricity by the year 2030 by about 7 quads. I would just be interested in the panel's reaction to that particular projection as to whether you feel that is conservative in the range of what is doable, or whether much more can be achieved and has been indicated.

Dr. Hirst. I'll take that.

First of all, the year 2030 is so far away that any projection can be safely made. We'll all be dead by then, so it hardly matters.

What troubles me about that particular forecast, and the National Energy Strategy in general, is that there is no link between the actions that the Federal Government should make today and next year and these wonderful goals. I mentioned in my testimony that we reviewed 30 electric utility plans. A key component of any resource plan is an action plan. What are you going to do in the next couple of years?

The National Energy Strategy is virtually silent on that. It's filled with lofty rhetoric, but very little about how you're going to actually get there.

So I have no way of judging whether that goal 40 years out is a reasonable one or an unreasonable one because the statement tells nothing about how they're going to get there.

Mr. Wolpe. I guess what I'm asking, though—assuming that you were in a position to implement precisely the kind of efficiency and R&D investments that would yield the greatest benefit return, what is achievable still? I remember back in the debates several years ago, we had—I'll stop there and let the panelists respond.

Dr. Hirst. The 7 quads in the year 2030 strikes me as a very modest goal for improving productivity in the electric utility sector. My study that I just mentioned suggests that we could cut electricity use by 20 percent in 20 years, which is a much larger reduction than what the National Energy Strategy has.

Mr. Geller. Just to add to that, I was going to pick up on the 20 year time frame. The estimate in the National Energy Strategy was for a reduction in power demand of about 45,000 megawatts—equivalent to about 45 large nuclear power plants—by the year 2010. As Eric indicated, that's a modest goal considering that there are something like 600,000 megawatts of power plants in the country today. That level is growing every year so that they're relatively conservative regarding the savings potential in electricity and other areas.

Furthermore, the efforts that they're proposing are totally inadequate, even to achieve the limited amount of savings that they identify. Their small $3 million or $5 million effort in integrated resource planning that barely scratches the surface in terms of the kind of support that the Federal Government should be providing to achieve the target they identified, or even going beyond that to what the potential is technically and economically.

Mr. **Wolpe**. Dr. Rosenfeld?

Dr. **Rosenfeld**. I would like to make a comment on that particular number, too.

Electricity today uses about 27 quads, I think, today. Forget growth. Now, I did the calculations for the National Academy panel, which was just announced last April 10th on electricity savings. I did the compilation of various people's estimates. EPRI, which tends to be on the conservative side, estimated 40 percent savings at cost of conserved energy, less than today's electricity even figured in growth.

I looked at nine other compilations and came out with the average, which the National Academy quoted at 50 percent potential savings. That would be half of 25 quads, which is 12 and a half quads, but in the next 10 or 15 years.

So that's just from doing the technology that we know we can do today, stuff that's already on the shelf and doesn't require any R&D. I'm with Eric. The National Academy—the national energy study stuff is very, very, very conservative.

Mr. **Wolpe**. Dr. Ross?

Dr. **Ross**. I will add one more comment because I thought I heard in your question the reference to the amount of fuel you would have to expend in order to produce the electricity and my colleagues have all been responding to the issue of how much more efficiently you could use the electricity once it was produced. But of course it is correct to say that there are substantial gains that could be made in improving the efficiency of producing electricity as well as in using the electricity, although we are running up to our thermodynamic limit. But we certainly can go from the present efficiency in the 30s up to efficiencies in the 50s and that's probably as far as we can go.

One of the critical historical developments in the 1960s and 1970s was the fact that we ran out of steam—shall I say—in terms of improving electricity—the efficiency of producing electricity. We are seeing now—with new gas turbine technologies and other related technologies—which were an opportunity created by research and development, although a lot of it was in ceramics and turbines in which R&D was not necessarily done by the Department of Energy. We're seeing the opportunity of moving those efficiencies into the 50s, and one certainly can in that connection save at least the 7 quads that you were quoting.

Mr. **Wolpe**. Obviously, this is a very critical question, even though it is difficult to make projections not linked to specific policies. My question is in fact, If we had the right policies, what is achievable? I think in terms of the policy in this Congress, unless we can begin to at least have some benchmarks for what is realistic, both in terms of existing technologies and in terms of potential technologies that are near the point of commercialization. It's going to be difficult to weigh in against the competing interests that are arguing for their subsidy and their support.

To the extent that we can make a stronger case for dramatic gain in displacement of petroleum as a result of improved efficiency, either through the use of electricity or through its production, you then I think have a much stronger case for at least raising questions about the extent of the subsidization of some of the nuclear technologies and the rest, and given the fact that we have a finite pool of dollars at this point, those trade-offs I think are very, very critical.

So I'm anxious to kind of identify as much that has been done in the way of that kind of scenario building and forecasting because I think that can be enormously helpful in our discussions here.

I recall back a decade ago that there was some fascinating work that was done on the issue of weatherization of homes—everything from insulation to the issue of window improvements and the like—that indicated that we could be displacing far more petroleum by national weatherization program at a cost at that point in time of some—between $10 and $12 per barrel of oil equivalent, at a time when the world market price of oil was in the neighborhood of $30 or thereabouts. Do we have any updated numbers? Has anybody tried to take a look at just the issue of building overall—of home building—of weatherization of our homes?

Mr. **Guinn**. Let me take that for a moment. New York has a program of auditing residential housing run through our utilities, which started in the late 1970s. The program has resulted in 700 million barrels of oil equivalent being saved—and since our plants tend to run oil on the margin, it tends to actually be barrels of oil—over the 10 or 12 year program. I don't know—I don't have the cost number in my head to get it into barrels of oil, but it would be below the level you're talking about.

There have been a great number of evaluations of these programs, and we could provide those to you.

Mr. **Wolpe**. Would you? I think that would be very useful.

Mr. **Guinn**. We have to other committees, so we can provide those to you.

Mr. **Wolpe**. That would be very helpful.

In the National Energy Strategy, on page 140 of the document, there is a chart laying out a time line for the commercial introduction of selected energy technologies. In that chart, there is a discussion of buildings technology. They identify high efficiency lighting, R-10 plus windows, and electrochromic windows as technologies that would be available for commercial introduction somewhere between the time of 2000 and 2005. I wonder what your assessment is of that? Is that, again, something that if we were to put more effort in it could be done much more quickly than that? What would be your assessment of that projection?

Dr. **Rosenfeld**. Since we developed those windows at Lawrence Berkeley Lab, I think I can talk to that.

When the energy crisis struck in 1973, OPEC won. The window technology in the United States was about half just old-fashioned single-glazed windows and about half double-glazed windows in the northern part of the country. A single-glazed window is called R-1 and a double-glazed window has two units of resistance and it is R-2.

We developed a low emissivity window, which is a way to coat those existing double-glazed windows, which are now R-4 and they are adopted by all standard window manufacturers. If you buy a good window from Anderson or Pella, or Norman, you can't buy—or Marvins—you can't buy anything else. So those are on the market now.

The challenge is to make them even twice as good. We have already demonstrated at Lawrence Berkeley Lab a window like this--I happened to have brought a sample. This is an R-8 window. It's as good as eight single panes of window. It is just going into production. It is designed to have a 3 year payback. Windows last 20 to 25 years, so that's a pretty good return on your investment. It's ready to go into the market now.

Now we will turn our research to the electrochromics, which you mentioned, and things that will actually respond electrically so as to make them respond to the weather and let in the light when you can afford it and reflect the sunlight when you don't want it. But all those things are in a much closer time scale. With accelerated R&D we can have those products ready for the market in 10 years. The super window is practically ready for the market today.

Mr. SCHEUER. Will my colleague yield for a question?

Mr. WOLPE. Surely.

Mr. SCHEUER. Wouldn't this be an area where you have something with four times the energy savings potential of normal windows—for the Federal Government to come in and make a very substantial purchase for all kinds of Federal buildings around the country—as a way of moving this from the laboratory to production, it might be that a significant Federal order could move it into production.

Dr. ROSENFELD. I think you're exactly right, Mr. Chairman.

Mr. SCHEUER. I yield back to my colleague.

Mr. WOLPE. I thank you.

I've taken a lot of time, but I wonder if I can just ask one last kind of two part question and just invite the panel's reactions. One is, I would be interested in some assessment of the potential, in terms of savings, to be achieved by a significant integrated resource management effort. What kinds of gains can be realized based upon the knowledge that we've already acquired in those success stories?

Second, I raised questions when Admiral Watkins was before us about the incredibly high percentage of the total increased R&D budget that is being requested for nuclear work—nuclear fission in particular, new generation of reactors and the like—because it didn't seem to me that was consistent with the announced goal of displacement of petroleum, given the amount of petroleum that goes into the generation of electricity being so minuscule, to which the response was:

> Well, we have this tremendous increase in electricity demand coming down the road, and that if we move into electric vehicles that will again increase dramatically and we will always have this very dramatic need for base load electricity generation, and better nuclear than fossil for environmental concerns.

I would just be interested in the kind of broad reaction to that kind of analysis as to whether or not indeed if we move in the direction of electricity vehicles and hybrid vehicles of one type or another that might combine photovoltaic cells with other batteries and the rest—whether we can think possibly in the different kind of scenario that would move away from the heavy emphasis upon centralized base load technologies to a more decentralized generation of energy.

Dr. **Hirst**. I think we can. It's clear that the country is becoming more and more electrified. As I mentioned, the fraction of total energy use accounted for by electricity increases steadily. If we move to electric vehicles, particularly in places like the south coast air base in California, that trend will continue.

I would disagree with Secretary Watkins that the only way to meet that increasing demand is through more nuclear power. We've talked quite a bit here about improving energy efficiency—Art Rosenfeld has shown a couple of technologies—so there is substantial opportunities on the demand side.

Marc mentioned improvements on the supply side—things like improved combined cycle gas fired units—plus renewable resources. Also in Southern California you have the Luz solar energy fields and in Northern California you have wind and there have been dramatic improvements in photovoltaic.

So I think there are lots of alternatives we have both to reduce the growth in the demand for electricity while maintaining the same comfort, amenity, convenience levels that we would otherwise have and to provide alternative ways to supply that electricity.

So I think nuclear may turn out to be a very important option, but it will be only one of many options that we use to meet the growing demand for electric energy services.

Dr. **Rosenfeld**. Mr. Wolpe, I would like to make—as a Californian—we've had a lot of good stuff from New York, so I have to get in a word for California. In the present California plans for electricity—this is consistent with what Eric is saying—as I remember, output of the next projected 10 gigawatts—that is 10,000 megawatts of installed capacity needed, or what would normally be needed—the California utilities expect to get 70 percent of that from conservation. That leaves 30 percent from new electricity, and none of it—I repeat, none of it—is going to come from central generating plants. It is all going to come either from small cogeneration plants, which are efficient because you can use the heat, or from renewables.

On the west coast of the United States—and I say this twice to make sure nobody misses it—on the entire west coast of the United States, as far as I know, there is one small central plant planned, and I think it's about to be scrubbed. It's in San Diego, and it depends on the status of a merger. That leaves the entire west coast of the United States with essentially no central generation plant for the foreseeable future. We're going to need more electricity, but it's not going to come from the conventional central plants.

Dr. **Ross**. I would like to comment, Mr. Wolpe, on the first part of your question. Integrated resource planning, which was ably discussed by Eric, has not yet really been implemented in Michigan, and in addition, it has not yet really been implemented in the industrial sector. We are just beginning to explore that. There is an enormous amount of institutional work as to how you would enable a utility to help make the investments in process improvements in industry.

I think—I've done some estimates, but they are extremely crude—that that's the most interesting possibility for Government enhancement of industrial efficiency improvement because the problem in the industry is not that they lack technical skills, the way a householder does, but they lack the financing for this kind of investment which is not so closely related to their products.

So there is an enormous potential there, one that we are not moving rapidly to tap.

Mr. WOLPE. Thank you very much. I appreciate that.

Thank you, Mr. Chairman.

Mr. SCHEUER. Congressman Ritter of Pennsylvania.

[The prepared opening statement of Mr. Ritter follows:]

OPENING STATEMENT
HON. DON RITTER (R-PA)
DEPARTMENT OF ENERGY
ENERGY CONSERVATION PROGRAM
APRIL 17, 1991

THANK YOU, MR. CHAIRMAN. I COMMEND YOU FOR YOUR LEADERSHIP ON THE ISSUE OF ENERGY CONSERVATION AND EFFICIENCY. AMERICA'S EFFORTS IN ENERGY CONSERVATION AND GREATER ENERGY EFFICIENCY HAVE THE POTENTIAL TO REDUCE ENERGY COSTS TO CONSUMERS, ENHANCE THE QUALITY OF OUR ENVIRONMENT, PROMOTE A STRONG ECONOMY, AND DECREASE OUR DEPENDENCE ON IMPORTED OIL.

THE POTENTIAL OF CONSERVATION AND EFFICIENCY IS SUBSTANTIAL. THE DEPARTMENT OF ENERGY ESTIMATES THAT THE USE OF EXISTING COST-EFFECTIVE TECHNOLOGY COULD SAVE AS MUCH AS 14 QUADS OF THE ENERGY DEMAND PREDICTED FOR THE YEAR 2010. THE NATIONAL ACADEMY OF SCIENCES, IN ITS RECENT REPORT ON MEASURES TO MITIGATE GLOBAL CLIMATE CHANGE, CALLS FOR THE

WIDESPREAD ADOPTION OF CONSERVATION MEASURES.

THE NATIONAL ENERGY STRATEGY CONTAINS A NUMBER OF INITIATIVES DESIGNED TO INCREASE ENERGY EFFICIENCY AND PROMOTE GREATER CONSERVATION. AMONG THESE INITIATIVES ARE A SHARP INCREASE IN FUNDING FOR ENERGY CONSERVATION PROGRAMS AT THE DEPARTMENT OF ENERGY.

THE CONSERVATION R&D PROGRAM AT DOE SUPPORTS A WIDE RANGE OF ACTIVITIES, FROM PROMOTION OF INTEGRATED RESOURCE PLANNING IN THE UTILITY SECTOR, TO DEVELOPMENT OF MORE ENERGY-EFFICIENT BUILDING TECHNOLOGIES, TO RESEARCH EXAMINING THE POTENTIAL OF ALTERNATE FUELS IN VEHICULAR APPLICATIONS. THIS LAST ACTIVITY IS PERHAPS PARAMOUNT; IF WE ARE TO BREAK THE GRIP THAT IMPORTED OIL HAS ON US, WE WILL NEED VEHICLES WHICH RUN ON A

DIFFERENT KIND OF FUEL.

THE FY 92 BUDGET FOR CONSERVATION R&D ACTIVITIES CONTAINS DOUBLE-DIGIT INCREASE FOR MANY PROGRAMS. THE DEPARTMENT OF ENERGY'S CONSERVATION PROGRAM, NOW REORGANIZED UNDER THE LEADERSHIP OF MIKE DAVIS, IS COMMITTED TO DEVELOPING TECHNOLOGIES WHICH CAN MAKE A DIFFERENCE IN ALL SECTORS OF THE ECONOMY. I APPLAUD THE DOE'S RENEWED FOCUS ON CONSERVATION AND EFFICIENCY, AND I LOOK FORWARD TO HEARING FROM OUR WITNESSES ON HOW THAT COMMITMENT COULD BE STRENGTHENED FURTHER.

Mr. RITTER. Thanks, Mr. Chairman.

I want to apologize to our distinguished panel. We are in the throes of a railroad strike, and yours truly is the Ranking Republican on that Subcommittee that is holding a hearing at this moment. So, I'm just here for a short period of time. But, I did want to just engage briefly on this issue.

I would like to have your thoughts on something that has occurred to me in this whole area of energy conservation. First of all, I believe energy conservation is a clear winner for America. It is a clear winner economically. It even has socially redeeming values, as far as I'm concerned. So, that's sort of where I'm coming from.

Taking it one step further, though, we did to some extent go to war in the Persian Gulf over who controls the world's oil. If this were two Central African dictatorships beating up on each other, I'm not sure we would have intervened. That's not taking anything away from the moral high ground, but there is some reality check on occasion when we do these things.

That oil is mostly used in America for transportation fuel. To the extent that we burn it to produce electricity, we're making a great error. Those—Charles, you do great work in New York State. But, I have to tell you that your Governor's decision to keep shut down a $5.5 billion electric energy generating capacity, when that area of New York and New York State is so dependent on Bering oil for electricity, I think is tragic. But aside from that, the dependence—the real problem we face is even with CAFE and even with conservation. We still consume more oil in transportation fuels, and we are more dependent. How do we attack? If you want to put—the real point position on energy conservation should be on transportation fuels because it's dangerous. We may not be so fortunate and so victorious in the next go around in a global conflict over oil.

How do we focus more on what is the real problem, the transportation fuel dependence that is a foreign oil dependence and also a very expensive trade deficit? In addition to national security dangers, there are economic dangers in terms of America's trade deficit. How does—are you convinced that the focal point for conservation should be in transportation fuel? If so, how do you mobilize our conservation efforts toward the replacement of this dangerous and expensive imported commodity?

Dr. ROSS. Let me respond to that. In my testimony, I talked about new technology opportunities, which I think we're all in a general sense familiar with. Before getting into it, let me remark that I think your emphasis is entirely correct. When it comes to petroleum, we really are talking about transportation fuels, fuels used in highly isolated sites where gas lines don't get, and in many cases when we read that the electricity industry is using petroleum—the by-products—we wouldn't have those by-products if we weren't producing the transportation fuel, and similarly industrial uses of petroleum in many cases.

So let's agree—I won't repeat that there are these enormous opportunities for new technology in the transportation sector—how would we get there? How would we use those technologies if they were developed? Some of them have been developed already. Many are waiting for a little more effort to develop them—hybrid cars, fuel cell cars—we've just started a program in the Office of Transportation Technology in the fuel cell area which looks very promising, although we can't tell how it's going to turn out.

I think we need a two-pronged kind of program. One is, the regulatory program that we're familiar with, extending that program. But it's not—it's I think a cornerstone. You can't get there by revolutionizing the price of fuels. That would be hitting Americans over the head who have made other arrangements. All our cities, all our rural areas, including rural Pennsylvania, are based on reasonably priced fuels. So how do you move people—how do you persuade people or motivate them to want new technology in the transportation area?

We have a very nice proposal which was invented in part by my colleague, Professor Rosenfeld, which is fees—the gas guzzler tax—fees in the new car showroom on very inefficient vehicles which are societally damaging and rebates on highly efficient vehicles that are societally valuable. I think you need that economic incentive. I think it's impractical to achieve it primarily through gasoline taxes or methods of that kind. We need a mechanism to move the market.

Mr. **Ritter**. We do. I agree with you. None of us is up here screaming holy murder about the low cost of gasoline. We've grown up on it in America. It's not just now the last 5 years, it's the last 50 years. And yet the societies have had this experience in building these vehicles at a certain efficiency that continues on into today. You kind of stand where ~~you sit.~~ We do make very good large cars.

My worry is, in extending CAFE—and I know we have some disagreements with members on the Committee—but I don't think anybody is ignoring the deep difficulties of Detroit. For example—now listen to this—the Mercury Marquis, which is a new line redone American large Mercury, Ford Limited, large car kind of things that the American consumer seems to want, the kind of thing that American manufacturers can produce quite competitively.

Do you realize that 70 percent of those automobiles have foreign content so that they—the Mercury Marquis and the Ford Limited are actually characterized as foreign cars to get out from under CAFE. This is the potential disaster for auto workers and American manufacturing. I don't think we can afford to lose the U.S. automobile industry. I think it's still a high-tech lynch pin cornerstone to the American manufacturing economy.

But these are some of the problems.

Mr. **Scheuer**. May I just interject one comment on my time and not on yours?

Mr. **Ritter**. Sure, go right ahead.

Mr. **Scheuer**. I have a bill in now that is going to the Energy Subcommittee of the Commerce Committee that would add to the price of each car either an incentive or a disincentive—either there would be a little tax or a little premium—in each category of car going from the biggest and the heaviest down to the smallest and the lightest. In each category, it would say to the consumer: "If you will pick within this category of your choice a fuel efficient car, a gas sipper rather than a gas guzzler, we will give you a premium."

We will say for the gas guzzlers, "If you pick this car, you are going to pay a little penalty." So that within each group, and within all the groups together, it would be revenue neutral. But in each category, there would be an incentive to purchase the fuel efficient car and a disincentive to purchase the fuel inefficient car.

I don't want to ask you on Congressman Ritter's time how that idea grabs you, but I will ask you later on when it comes back to my time.

I yield back to Congressman Ritter.

Mr. **Ritter**. I think it's an interesting idea, and Dr. Ross was just talking about something like that in purchasing incentives.

Dr. Ross. Let me comment very briefly on your remarks about the foreign content.

We have a problem here. We have a problem in United States industry generally, with the exception of a few industries like aircraft, pharmaceuticals, and electronics—some areas of electronics. We can't simply accept it and say, "We'd better protect our industry. We'd better not challenge them too much." We have to bite the bullet, it seems to me, and challenge them, try to provide the technical training and assistance which is needed. But I think we need to challenge them. Right now, we are faced with the fact that General Motors is the only company which is producing high performance engines of the big three. The Japanese seem to be able to turn around and produce——

Mr. **Ritter**. You mean the 4 valve 4 cylinder?

Mr. Ross. That's right. That kind of engine. The Ford and Chrysler cars with those engines—all those engines are Japanese engines, unfortunately. I don't think we can afford to say, "Well, that means we better draw back and not challenge our companies."

Mr. **Ritter**. But, you didn't answer the question. The question is, in order to avoid CAFE, to produce these large cars, the big automobile manufacturers have characterized their cars as foreign cars by purposely importing. They didn't want to necessarily. They didn't need to, but they did it in order to conform to CAFE. I think that's a real—if there's a silver lining to CAFE, there may be a big cloud out there.

Mr. **Geller**. Let me jump in and say specifically on that point—of course, it cuts both ways. The CAFE standards give the manufacturers to keep the smaller cars that otherwise have been moving overseas in the United States so that it helps them in their domestic CAFE average to come up to the standard level.

More generally, I would like to comment that I think it's correct that you have identified a problem area in the CAFE standards. Let's not throw away the baby with the bath water.

Mr. **Ritter**. Your comment that it encourages manufacturers to keep the real small cars—I think the members of this Subcommittee are very much aware because the data has come out several times that to a very large extent Detroit is meeting CAFE standards by importing cars mostly from Japan.

Mr. **Geller**. They have to meet it on their——

Mr. **Ritter**. See, but the Colt is not a Colt. It's not an American car. It's a foreign car, but it is incorporated as an American car to meet the——

Mr. **Geller**. It surpasses the domestic content level so that it can be counted as a domestic car. It's produced enough in Michigan and wherever it's produced so that it counts in the domestic——

Mr. RITTER. No, there's no domestic content requirement, as I understand it, to be characterized as a domestic car. But, there is a content requirement that characterizes what is a foreign car.

Mr. GELLER. That is correct, but it works both ways. Each manufacturer——

Mr. RITTER. Yes, if you have more than 31 percent.

Mr. GELLER [continuing]. On what's considered their domestic fleet and their import fleet.

Mr. RITTER. Right, but if it's 31 percent, look at how we're meeting CAFE standards. In other words, it's 70 percent to be characterized as a foreign car. That's what we're doing with Marquis and Ford Limited, so it's 30 percent to be characterized as a domestic car basically. So, we're losing the cars that we know how to make, and we're importing the cars that we don't know how to make. It's kind of a difficult mix. I'm not——

Mr. GELLER. They're largely domestic cars in order to qualify as a domestic car in the CAFE calculation.

Mr. RITTER. You need above 31 percent, I guess—you need above a 30 percent content.

Mr. GELLER. Yes, and that's helping us to keep the big three keeping above 30 percent on those smaller cars.

Mr. RITTER. But, we could have produced the larger cars with 85 percent content.

Mr. GELLER. Perhaps. I accept that that's an area to look at, but let's remember that the CAFE regulations—you talked about the gap between efficiencies here and in Europe, and in Japan, where we have very different gasoline prices. That gap was enormous 15 or 20 years ago. Our CAFE standards, along with our continuing cheap gasoline, allowed us to close that gap, to a great degree. The difference in average efficiency of new cars in the United States and in Europe now is quite small. It's only a few miles per gallon.

Mr. RITTER. But, you missed the point. The point is that we're making those standards because we're importing these cars.

Mr. GELLER. And our domestic cars in all size classes are much more efficient today than they were 50 years ago.

Mr. RITTER. They are. I'll grant you, there is that, but there is a greater efficiency overall. But, in order to meet the imposed mandated CAFE standards, we have basically imported whole fleets of foreign cars with greater than 30 percent. And, now we're starting to take larger cars, which we know how to produce, and are actually putting foreign car content levels in them so that they don't get counted against a fleet average. I'm just saying that it's something that we should really consider and not sweep under the rug.

I have to get back to my rail strike hearing. This is a subject, as you can see, very dear to my heart, and I really apologize for having to leave you all.

Thank you.

Mr. SCHEUER. After Art Rosenfeld, I will recognize you, Dr. Ross. I think you seem to be chomping at the bit.

Dr. Rosenfeld?

Dr. ROSENFELD. My remark was both to Mr. Ritter and to you, and that is, I want to point out—I want to elaborate on the point you made, Mr. Chairman, that you can get around the CAFE problems with a profit motive. You raised this fee-bate idea. In fact, in

California, the bill was based under the name "Drive Plus", and it was written by two of my graduate students and me, so I have thought about it a lot.

Mr. SCHEUER. Is that a similar proposal?

Dr. ROSENFELD. Yes. It was passed by the California Legislature last year. It was vetoed by then-Governor Deukmajian, but the new Governor likes it, so it will go through the legislature and not be vetoed this time.

Mr. SCHEUER. And it does substantially what I described?

Dr. ROSENFELD. Yes. Instead of having a flat 7 percent registration fee for new cars, it will vary from 15 percent for the worst cars—for the car that Mr. Ritter just discussed, for example—down to zero percent for the best cars.

Mr. SCHEUER. And that's within each category of cars?

Dr. ROSENFELD. Yes. Well, in California, we didn't bother with the category, but I would recommend the category if you did it Federally.

The point I would like to make on this is the following. Let's consider the luxury car class. To make a 25 percent improvement in fuel economy, according to papers by my learned colleague Marc Ross—and also by the Department of Energy, so I think they agree—it only costs around somewhere between $600 and $700 to take even a Cadillac and improve its fuel economy—improve its miles per gallon by 32 percent. But that means saving fuel by 25 percent—$700 per car.

If you have that sort of income transfer in a drive plus fee-bate bill, then General Motors or Chrysler will happily make the better car. After all, if the consumer suddenly has $700 more in his pocket to pay for it, General Motors will be happy to fill that need. They will, in fact, probably raise the price by $500 making it more profitable, and the consumer will still get the $200 in his pocket and save on the gasoline, so he will have a good deal.

Mr. SCHEUER. That is truly a win-win situation by anybody's standards.

Dr. ROSS. Mr. Ritter has left so I really don't need to discuss the——

Mr. SCHEUER. I wish you would continue for the record.

Dr. ROSS. There is of course this dual structure in the CAFE standards. It's not an integral part of what CAFE must be and what automotive standards must be. As my colleague just said, you don't throw the baby out with the bath water. Howard said that, and I agree with him entirely.

We should rethink technicalities of that kind of legislation. In this case, I don't know the answer. We have the foreign made cars have their CAFE, and the domestically made cars have their CAFE, and of course there are games to be played by manufacturers in moving those cars from one of those groups to another, but the net problem is not at all clear because we gain—the more manufacturing of small cars, like the Saturn, where we lose the manufacture of some large cars in their effort to make use of that technicality in the CAFE rule. I'm not sure how it comes out. It is something to think about. I agree with him in that sense.

Mr. SCHEUER. Congresswoman Horn of Missouri?

[The prepared statement of Ms. Horn follows:]

Statement of Joan Kelly Horn before the Committee on Science, Space, and Technology, Subc. on Environment, April 17, 1991

Thank you Mr. Chairman. I welcome the distinguished panel and look forward to their testimony.

We all know the importance of energy conservation to our nation's energy security and the major part it must play in any national energy strategy. Along with alternative energy sources, savings from improved efficiency and other kinds of conservation could contribute more to our nation's energy security than new sources of domestic oil. For this reason, it is imperative that we give our firm support to energy conservation R & D. Furthermore, to be effective, this support must be sustained from year to year, rather than being subject to the whims of budget cutters.

By bringing conservation to all segments of our economy, from lighting and heating our public and private buildings to the transmission of our electrical power, we improve our nation's ability to compete internationally by lowering the cost of the energy needed to provide given products and services. Such an improvement is vital to retain and increase our markets at home and abroad.

It is important that we not wait for a crisis before we begin to increase the efficiency with which we use energy. Our allies and trading competitors are certainly not waiting. Instead we should regard improved energy efficiency as a challenge for our world renowned high technology. Success in meeting this challenge will pay dividends in the future, in improved competitiveness, increased energy security and less air pollution.

It is important that we look at funding for energy conservation R & D not just as an expenditure, but as an investment in our nation's improved industrial capacity and energy efficiency. We must reverse the trend of the past decade from neglect of this vital form of R & D to strong support for these programs which improve our overall economy.

As we hear from today's witnesses, I look forward to their testimony on what can be done to improve energy conservation in our nation. I am especially interested in hearing what can be done in the near term to save energy now being wasted in our buildings. I am also interested in what the in what the average consumer can do for energy conservation.

Again, I look forward to hearing the testimony from today's witnesses and know that we will benefit from their expertise in improving energy conservation in all segments of our nation's economy.

Ms. HORN. Thank you, Mr. Chairman.

My apologies. I was also double scheduled this morning, which happens often. Not hearing the full testimony of the distinguished panel, I do have all the papers and will be continuing to review them.

I will, because of that, ask a more general question. If it has already been covered, I will read the record and not ask you to repeat yourselves.

We have throughout our society such incredible disincentives for people to do what we all agree they ought to be doing, and yet we have—properly so—a Government that believes in the least government the better. I know you probably, although you're not policy makers yourselves, have had occasion to think about that and perhaps have some judgments. In Missouri we now have 95 cent gasoline, which does not give anybody much of an incentive to conserve, as in many European and other countries where it is $4 or $5 a gallon. My thought is that if our gasoline indeed cost what the real costs are to our society, we would do a lot better job. In other words, if the environmental costs were factored in, the military costs, the health care costs, we would all do a better job of conserving.

We have the same thing with our short term—someone mentioned a householder not having information, not having the perhaps cash on hand, just not knowing things they might do in their own home to effect efficiencies, whereas businesses, companies, are more likely to know this, but not have the financial wherewithal, even if they know there's a 3, 4, or 5 year payback to make any necessary conservation changes even to such a thing as lighting.

It's a quandary. It's a quandary for us. If you would care to touch lightly on a way to recognizing the sacredness in our society of the least interference and move all of us to where we think we all should be—if there is anyone who has addressed that particularly, you might start.

Dr. HIRST. Your comments go to the issue of market barriers. Everybody likes markets, and they're wonderful when they work well, but in this particular case—that is, the energy market—they don't work well. That's very important because of the adverse public effects of excessive energy consumption, effects that we've all talked about having to do with pollution, economic productivity, and national security. What we have are a lot of barriers that stand between energy consumers in every sector of the economy and the kinds of energy-efficient investments that we should be making.

You have touched on a couple having to do with price, the fact that the price of fuels do not include the environmental costs associated with producing them. They don't include for petroleum the cost of importing fuels and our dependence on foreign oil supplies and our recent action in the Middle East.

In many cases, consumers don't have good information on the energy efficiency choices that face them. In many cases, it's not the consumers making the decision. If you buy a new house, it's more than likely that it's the builder, not the home buyer, who selects the heating equipment, the levels of insulation, the kinds of windows, the appliances, and he is going to make decisions on the basis of lowest first cost, not lowest life cycle cost. So the householder then that buys and lives in the house really doesn't make the choices of that energy efficiency.

I could go on and on, but there are lots of market barriers. Because of these, and because energy efficiency is so important, we really need the Federal Government to get in there and take a leadership role to help overcome those market barriers.

Ms. HORN. Thank you, and I certainly agree.

Yes, Dr. Ross?

Dr. ROSS. I would just like to add that there is one way to overcome those market barriers, unfortunately. This is a difficult area and we need one kind of policy making in terms of utility roles, which Eric has discussed. We need policies in the area of mass produced products, which are policies which are not onerous in the utility area. In each different area, we need to be ingenious and proactive and make policies that fit the situation.

In the automobile area, we need more than regulatory standards, as we've been discussing, although I think strength in regulatory standards are the cornerstone. In appliances, we have established a very powerful performance standard program. I think we're going to reap enormous benefits from that. We need a lot of policies to encourage the research and development which might otherwise be done much, much more slowly by the private sector.

So it is a complex mix, and it is a real challenge for the policy makers to do that, to realize that there isn't just one answer, like an energy tax. There just isn't one answer like that.

Mr. GELLER. Could I say a few words about the whole issue of gasoline taxes?

Our organization has advocated increasing the gasoline tax substantially. We have advocated a 50 cent per gallon increase in the gasoline tax, phased in over a number of years to help us address this problem of—95 cents a gallon, nobody cares.

We have taken a lot of heat for it. It's not popular with the public. Politically, it's a very hard sell, and perhaps suicidal to get out in front on something like that.

I've concluded that going at it head on is just not going to fly. I think we need to look for some other way of accomplishing the objective of showing the consumer a higher price when they're at the pump every week or every 2 weeks.

I think there is a very interesting proposal that has come up recently in California that may be a way of doing this. It has been proposed at the State level, but it could be done Federally as well. The concept is paying a portion of your car insurance at the gasoline pump. So instead of paying $800 per year per car in total to your insurance company, you would pay a base amount via your purchase of each gallon of gasoline—it might be $300 or $400 per car on the average through the insurance, and then individuals would go and purchase directly from the insurance company the additional coverage you want. The gasoline dealers would transfer that collection to the insurance companies State by State, or however.

That could increase the pump price significantly 50 cents a gallon or more. It would also have the benefit of everybody buying insurance. Everybody buys gasoline. You're not going to have people that don't pay auto insurance and have to get subsidized by the people that do. You're also going to tie the amount that you pay for insurance to the amount of gasoline that you buy, which is a tie to the amount of driving that you do. If you drive more, you're going to pay more for insurance.

I think it's a very interesting new proposal that has come up that may be a way to get at this. Of course, it's not an additional tax. There is no additional tax involved. It's simply paying a portion of your insurance at the gasoline pump.

Ms. **Horn**. It's just at the proposal level. That's not been tested anywhere. That's a very—you do the same thing for health care. Put that into a pool and start paying. I think it has great promise.

Dr. **Rosenfeld**. There's a special point about this. Again, I speak as a Californian, and I, again, have helped write these bills.

There's a special point about the insurance that makes it particularly appropriate. You see, insurance should be paid—one should charge for insurance by how many miles you drive. After all, you don't have a collision while you're parked in front of your house.

The trouble is that we just didn't do that in this country. So if you don't drive at all, it turns out your insurance rates are 15 percent cheaper. But that's hardly a reasonable way to do it. So we should couple insurance, under any conditions, to miles driven. If you do it with gasoline, you just have the advantage that you do some simple arithmetic. The average American pays $800 a year for insurance, he uses 400 gallons a year, that's $2 a gallon. If you charge for it at the pump, then all of a sudden, you might decide to ride pool, or you might decide to take public transit. The insurance is done more equitably and you just have a better system.

We ought to try it first with insurance, maybe later with other things. But insurance is crying for the change.

Ms. **Horn**. There's a very direct relationship. I agree with you there.

Mr. **Geller**. The National Organization of Women like this idea. Women drive less than men and are paying a disproportionate amount of insurance, given their amount of driving.

Ms. **Horn**. Thank you, Mr. Chairman. I have no other questions.

Mr. **Scheuer**. Thank you.

And now the ranking member of the full Science, Space, and Technology Committee, Congressman Bob Walker of Pennsylvania. We're delighted to have you.

Mr. **Walker**. I thank the Chairman. It's my pleasure to be here. Sorry to be late.

I was interested in the discussion here just previously. The rest of the world is suddenly figuring out that command economies don't work, and we seem to try to figure out ways to make our economy more and more a command economy. I get confused by that.

The other thing I would point out on the idea is that some of us are enthusiastic about moving toward alternative fuels. It seems to me that, if you tie the insurance system to your fuel system, you're going to have to charge that premium on alternative fuels as well because your insurance companies would then be dependent upon that payment as part of the system. You are, therefore, going to automatically out of the box raise the price of alternative fuels at the pump and thereby limit the accessibility in the marketplace to those.

Dr. Rosenfeld, do you want to——

Dr. **Rosenfeld**. That's exactly right because your risk of having an accident doesn't care at all about the sort of fuel in your fuel tank. This proposal for pay as you drive insurance is only an idea to make insurance rationale. If you want to subsidize alternative fuels, that's great, but not via the insurance industry, please.

Mr. **Walker**. I understand your point, but the point is that what you're doing is tying insurance to energy costs and you are going. The consumer, when he goes in to pay for a gallon of fuel, doesn't look at the fact that a substantial portion of that already is in State and Federal taxes. He is already blaming the energy economy for the total price that he is paying at the pump.

So, now you are going to add in another cost also that will be piled on top of alternative fuels. If what you're looking to do is drive motor vehicles off the road, period, then that makes some sense, I suppose. The bottom line is that for many of us, that isn't the direction that——

Dr. **Rosenfeld**. Excuse me, Mr. Walker, we're not trying to raise anybody's cost of transportation. I simply point out that I think everybody recognizes that insurance rates should be changed so as to be proportional to how many miles you drive. I repeat—you just don't have accidents while the car is in the garage.

Now, once you admit that, there are only two ways to fix it. You can either read somebody's odometer twice a year and charge in that way, or the easiest thing to do is to charge at the gallon. But insurance will be cheaper and transportation will be cheaper. We're not trying to mess with the transportation——

Mr. **Walker**. I would submit to you that it's an irrational system from the standpoint that you don't have accidents very much if you're driving long distance on freeways. And, you have, in fact, a lot of accidents if you're driving short distances in highly congested urban areas. Therefore, your proposal tends to be a disadvantage to people who do a lot of long-distance driving where their risk of accident is probably minimal, at best. So, it is not a totally rational system.

Dr. **Rosenfeld**. No, it's only a little better than what we have now. I repeat—you are exactly right. Marc Ross and I just looked into this. It turns out that per-mile on the freeway—you are exactly right—it's about twice safer, not 10 times safer. But, twice safer to drive on a freeway than on urban streets.

Mr. **Walker**. It depends on what kind of freeway you're driving on. In an urban freeway, that's true. I don't know what you used for measurement, but, in fact on rural freeways, rural interstates, you are significantly better off driving on a rural road and a rural freeway than you are on, for instance, the beltway around Washington or the beltway around Baltimore. Those would be freeways, but those would also be highly accident-prone, compared to driving on an interstate across the State of Nebraska, for example.

Dr. **Rosenfeld**. Mr. Walker, I do want to raise a point.

It is not perfect, of course, because we don't have an odometer that keeps track of perfection. However, if we take the total accident rate for the United States from insurance companies, it does cost you $800 a year on the average. That's partly from freeway driving, partly from city driving, and I'm sorry that it's not—the facts are that it costs you about $800 a year. It's better to charge that on the average per-mile than not to charge for a per-mile. That's all we're saying. It's not perfect, but it's better than nothing.

Mr. WALKER. But, I'm suggesting to you that that is not necessarily the best way of approaching it because there is a lot of per-mile driving that is far more dangerous than other per-mile driving. In other words, you are putting the premium on people that may drive the bulk of their mileage on extremely safe roads. A farmer, for instance, who drives 60 miles to the feed store in Nebraska, puts a lot of mileage on in a year going back and forth, running the route into town. Probably, his risk of accident in that particular venue is next to nil. And, yet, under your system, you're going to charge him more than the guy who drives 2 miles a day.

Dr. ROSENFELD. In Nebraska, the rates would be less. It would be regionalized.

Mr. WALKER. Again, it would not be regionalized. Let's use your State of California. My guess is that there are places in rural California where the same thing would be true, and, yet, it wouldn't be regionalized. They would be paying the same amount. You do an average for the State, as I understood it.

That gets it back past the point. My basic point goes back to the original point that I made. And, that is that if you are going to have the ability to introduce alternative fuels to the economy, what we don't want to do is pile a whole bunch of social costs on top of those alternative fuels. We ought to try to get, as far as we can, market-priced fuels into the marketplace where they can be used.

From that standpoint, I would just like to ask the panel what you think the potentials are for bringing hydrogen into the transportation fuels economy on a quicker pace than, for instance, that which is contemplated in the National Energy Strategy.

Dr. ROSS. I think that's a very interesting question. We don't have at the moment a hydrogen program within the Department of Energy, but there is a lot of development at work. Obviously, there is a lot of development work that would have to be done in producing, transporting, storing, and using hydrogen.

We do have a new program in the Office of Transportation Technology on fuel cells for automobiles—we were just talking about automobiles, so I guess I'm continuing with that thought.

Fuel cells are best adapted for hydrogen as a fuel. In fact, such vehicles, because of the high potential of efficiency with fuel cells—if that development work is really as successfully as one hopes—because of the high potential for efficiency of the energy system, it looks as if the fact that it's harder to store hydrogen than it is, say, gasoline would not be an overwhelming difficulty because you have a very efficient transformation of the energy. So the amount of hydrogen that you could put into a reasonable tank would in fact give you good range.

So it looks promising. We are not doing the research and development we need to do on producing, transporting, storing hydrogen. We should do so, along the lines of what you said. That would not be an inexpensive thing to do, to start moving on the R&D in that area.

Mr. **Walker**. I'm hopeful we can encourage the Department of Energy to be a little bit more sympathetic to what this Committee has outlined in the past. We had specifically asked the Department of Energy to put a line-item in place for hydrogen research. We got, in fact, approved in the House last year on the Appropriations Bill, the specific request for a line item for hydrogen. That was dropped in the conference, but, nevertheless, it has been made very clear, at least from this body, that that is something that we want.

The Department of Energy has thoroughly ignored that. I find that disappointing. How much money do you think we ought to be putting into that kind of a research program? I think we're at about $2 million right now.

Dr. Ross. I don't have a number. That's premature. I think the fuel cell work may lead the Department of Energy to change its mind on this. They should design a budget. Obviously, $2 million is a very small amount.

Mr. **Walker**. The other concept that I think we ought to be exploring—if I can get my two cents worth in—is one that the Japanese are moving toward fairly quickly. And, that is the use of the Wankel with hydrogen.

One of the problems with the Wankel engine in the use with fuels is that it has been a fairly rough-running, somewhat inefficient. Mazda has done a pretty good job of getting one up. But, the burn rate of hydrogen seems to be such that it makes the Wankel far more efficient and, of course, gives you a clean burn on it as well.

I'm disappointed that the Japanese are moving aggressively to take a look at that, and we have no work going on in this country whatsoever on use of Wankel technology. I would suggest that that might also be a place that we could do it.

Mr. Chairman, I have used my time. I thank you very much.

Mr. **Scheuer**. We have a roll call vote now. Congressman Swett hasn't had a chance to ask questions, so I'm going to ask him to take the chair and ask his questions.

I'm going to defer my questioning, and I will send you some questions by mail as soon as we get the transcript and hope that you will respond as soon as you possibly can.

This has been an incredibly interesting hearing. Really, we had too many creative thoughtful people in one hearing. We had a super-fluidity of riches.

I thank you very, very much. You will be hearing from me with some questions by mail.

Congressman Swett will now take over the chair. The remainder of the hearing for this panel—when he has finished his questions, he will adjourn the hearing at the call of the chair, and then when I get back—which will be in less than 10 minutes—we will go on to the succeeding panels, two and three.

I thank you very much for your fine testimony.

Mr. **Swett**. I thank the Chairman for the opportunity—although brief as it will be, I do have some very I hope important questions to ask. I first want to congratulate you for your excellent testimony. As the Chair mentioned earlier, and I was able to mention in my opening remarks, this is an area that is of deep, professional, and personal interest to me.

My experience has been in working with the industrial sector trying to promote conservation and efficiency through topping, bottoming, and combined cycle co-generation and other technologies that are out there in the work place and available.

I also agree with my good colleague, Mr. Walker, that we are not promoting the kinds of technologies or the kinds of development of fuels that we ought to be producing at this point in time to help us get off our dependency on foreign oil.

I will be very specific in that I have an interest in one area that we haven't really talked a lot about. It is driven by my participation in that technology as well. Essentially what I'm talking about is energy storage. I have cosponsored Chairman Brown's bill on increasing research and development on electric cars. I did so not because I think electric cars are the answer and the great questions that we have about energy, but because I see them as one way of getting at load leveling. Our society is increasingly moving toward a service society where we have drastic peaks in the daytime, and drastic valleys at night. I think that we need to spend much more time on developing technologies that will enable us to store that nighttime production, thereby enabling our power utilities to operate more efficiently on a level basis whereby they can drive that nighttime electricity production into the ground or some kind of storage media.

I would like to have you comment on that aspect at this time, please.

This is open to the panel. I will let you decide who ought to answer first.

Dr. Ross. I did mention the flywheel storage. We do have in DOE a fairly consistent and relatively strong electrochemical R&D program, which has led to some important progress with batteries.

Batteries are a tough subject from the point of view of science. Although we have made a lot of progress, we had hoped to make a lot more. The flywheel concept as an alternative to the battery, an alternative kind of mechanical battery, I think merits work. There is no work going on at all. That is a vehicle-energy storage concern concept, of course.

You were also talking about electrical storage and I would defer—I don't know if we have any expert on that subject here at the table.

Mr. Swett. My particular experience has been with compressed air energy storage, which is taking compression of air done by compressors, utilizing off peak electricity, driving it into the ground and releasing it in the daytime. Do any of you have experience with the fact that this country has potentially—well, not potentially, it has actually less than 2 percent storage capability in its energy production as compared to Europe and Japan that have well over 20 percent storage capacity.

Would you care to make a comment as to what significance that has on conservation efforts within this country.

Dr. Rosenfeld. Let me just understand the actual words.

In modern electricity, the only significant storage is either pumped storage, which we have some of it in the east and some in

California, but actually the most effective storage is just hydro, that is that you use your hydro power for peaking and you just don't use it during the night.

When you said that Germany—I think you said Germany or that some European countries have 20 percent storage. What do you really mean?

Mr. SWETT. They're utilizing technologies such as pumped hydro and compressed air energy storage where they are able to drive off-peak energy into a storage media. That capacity drastically outperforms the ability of the United States to do a comparative storage.

Dr. ROSENFELD. I think what you're saying is actually slightly different. Electricity—there is some pumped hydro in Europe. There is thermal storage, which is very popular in France and in Germany where you simply use off-peak electricity to heat ceramics over night and then use it in the daytime. But that's thermal storage and it's a solved problem.

As to the straight peaking issue, the most successful way to shade peaks in the United States with thermal storage is going into a number of commercial buildings in California. That's either cold water or ice storage where you do in fact chill the water at night or make the ice at night. Then you don't have to run your compressors in the daytime. That's extremely effective. It typically has 2 or 3 year payback time.

One of the things that intrigues me about that, since the Federal Energy Management Program has been mentioned somewhat. Although it's a rather standard practice in California, and there are thousands of buildings in the country that way, as far as I know, there is only one Federal building that way, and that's where it doesn't pay in Portland, Oregon, but because Bonneville Power Authority wanted to try the experiment.

As far as I know, it's a place where the Federal Government is completely privy to the switch.

Mr. SWETT. It is my understanding that in later panels we are going to hear from the Federal Government's representative that has some say in how the Government operates its conservation efforts. I'm looking forward to that testimony because I feel that we have been woefully inadequate in that arena.

It's not a sexy topic, and somehow we need to get before the public the real need that conservation can meet and the answers it can provide because we are looking at truly not only quick payback—as you said in some instances 3 years or shorter—but I think we're also looking at the ability to in essence generate electricity for $800 a kilowatt or less, as opposed to the typical $2,500 a kilowatt that is produced in our base load facilities at this time.

Dr. Hirst, you had a comment.

Dr. HIRST. I want to follow-up both on what you said and what Art said. You raised the issue that it's increasingly important of diurnal seasonal variations in the demand for electricity. Your comments emphasized the need for a supply strategy.

Art's comments point out that in almost every other energy issue there's a complementary demand side strategy. Art talked about thermal storage. Many utilities use interruptive and curtailable rates, they have time of use rates, they have direct load control programs that, for example, will cut off air conditioners and water heaters at the time the system peaks.

So I would urge you, in looking at this issue of meeting peak demands for electricity, to broaden the perspective and look not just at compressed air storage or pumped hydro, but also look at things that utilities can do on the demand side. They're often very much less expensive and more environmentally benign than some of the supply site strategies.

Mr. SWETT. I agree. That's a point well taken.

At this point in time, I don't have any further questions. As per the order of the Chair, I would like to close these hearings for a short term while I go and make my presence known on the floor. I appreciate your contributions and look forward to your continued contribution in the area of conservation in the months and years to come.

Thank you very much.

I adjourn this meeting temporarily.

[Recess.]

Mr. SCHEUER. We'll now hear Ms. Judy England-Joseph, Associate Director for Energy Issues, of the Resources, Community, and Economic Development Division of the United States General Accounting Office, Washington, D.C.

We're happy to have you, Ms. England-Joseph.

We're operating under a very tight timetable now. We're very late and this last roll call vote delayed us even more. Please take 5 minutes, then I'm sure we'll have some questions for you.

STATEMENT OF JUDY A. ENGLAND-JOSEPH, ASSOCIATE DIRECTOR FOR ENERGY ISSUES, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION, U.S. GENERAL ACCOUNTING OFFICE, WASHINGTON, DC, ACCOMPANIED BY CHARLES W. BAUSELL, JR., ASSOCIATE DIRECTOR, AND CHRISTINE FISHKIN

Ms. ENGLAND-JOSEPH. Mr. Chairman, we appreciate the opportunity to appear before you today to discuss the energy conservation and efficiency aspects of the Administration's recent National Energy Strategy, and our recent report on the Department of Energy's energy conservation research and development programs.

I would like to make some introductions. First, to my right is Charles Bausell, who is the Assistant Director responsible for our work in the National Energy Strategy area; and to my left is Christine Fishkin, who was responsible for our work in our report on the energy conservation R&D programs at DOE.

As you know, sir, the National Energy Strategy established the Administration's long range blueprint for a more efficient, secure, and environmentally sound energy future for the United States and its allies.

In summary, however, we question whether the National Energy Strategy will succeed in achieving its energy efficiency goals. The current NES is not comprehensive because it does not contain proposals that address the possibility that energy prices may remain relatively low into the future. Relatively low prices reduce the urgency for developing and using energy efficient technologies. Yet, the National Energy Strategy relies to a large extent on the development and adoption of these energy efficiency technologies to reduce energy consumption.

Current energy prices do not reflect all of the costs to society of obtaining and using energy. For example, as you heard this morning, our heavy use of fossil fuels produces a range of adverse environmental consequences. Higher energy prices that reduce energy consumption would correspondingly reduce environmental pollution.

The Administration considered and rejected policy measures, such as energy taxes, aimed at raising the price of energy because of their anticipated effects on the economy, yet Energy's own Oak Ridge National Laboratory noted that one primary barrier to the adoption and use of energy efficient technology is distorted fuel prices, prices which are too low because they do not fully reflect the environmental and social costs associated with fuel's production, conversion, transportation, and use.

There is further evidence that the market price for energy may be too low. The Secretary of Energy's Advisory Board reviewed the National Energy Strategy's interim report and cautioned that if the National Energy Policy is going to be one of relying on market forces to determine energy choices, options must be considered to ensure that all the costs of energy production and use are reflected in market prices.

Mr. SCHEUER. When you say all the costs, you mean the environmental costs as well?

Ms. ENGLAND-JOSEPH. Yes, sir.

Mr. SCHEUER. Thank you.

Ms. ENGLAND-JOSEPH. A similar view has been presented by the President's Council of Economic Advisors when they reported in February of this year that private market forces are unlikely to give adequate weight to national security and environmental considerations in setting energy prices.

Weaknesses in the National Energy Strategy are further illustrated by limitations of the DOE's modeling that raises questions about the validity of DOE's projections of the effect of implementing the National Energy Strategy.

The National Academy of Sciences reported that the NES' energy policy modeling was hampered by difficulties in forecasting technological change, possibly over-optimistic assumptions regarding new or alternative energy supply and end-use technologies, and relatively poor data quality on energy demand. Therefore, policy makers should be aware of the great uncertainty associated with such projections.

We have previously reported that DOE's energy conservation R&D management and planning needs to be strengthened. DOE has implemented some but not all of our recommendations. They have implemented, or are taking action to implement, our recommendations that it develop and use a uniform methodology to put projects in priority; to include technology transfer milestones in its multi-year plans; to include a much more systematic approach to addressing technology transfer issues; and develop conservation R&D plans at varying funding levels in order to better support DOE's budget process.

Some of these actions are being taken in connection with the implementation of the Secretary's recently announced agency-wide Strategic Planning Initiative. However, DOE has not implemented our recommendation to include information on individual projects in their multi-year plan. Further, DOE has not implemented our recommendation for top-level reviews of individual projects. And finally, DOE has not yet implemented our recommendation that the cognizant deputy assistant secretaries be required to have independent peer reviews conducted annually, and examine those peer review recommendations as a part of their overall multi-year planning process.

DOE agreed with our findings and informed us that within the next 6 months an evaluation program implementing our recommendation for mandatory independent review will be reestablished. In our view, the program should be reactivated at the earliest possible time.

In conclusion, a well-conceived and properly executed National Energy Strategy is important to our economic and environmental well-being, and to our national security. The Nation's vision on these issues must necessarily extend well into the 21st century if we are to be fully prepared for the alternative energy futures we might face.

As such, we believe that the National Energy Strategy needs to consider a fuller range of energy efficiency and conservation policies and options, and that the Department of Energy's R&D efforts must be managed effectively to support the overall energy conservation and efficiency effort.

The Administration's approach of depending on R&D and the dissemination of information on energy efficient technologies may not be as effective as projected if current low oil prices continue. We believe that significant in-roads against energy inefficiency are more likely to be realized if the price of energy better reflects all of its costs. Simply put, if American households and businesses find it in their best financial self-interest to use energy efficiently, they will likely do so.

This ends my formal remarks, Mr. Chairman. I will be happy to answer any questions you might have.

[The prepared statement of Ms. England-Joseph follows:]

United States General Accounting Office

GAO Testimony

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Balanced Approach and Improved R&D Management Needed to Achieve Energy Efficiency Objectives

Statement of
Judy A. England-Joseph
Associate Director, Energy Issues
Resources, Community, and Economic
Development Division

Before the
Subcommittee on Environment
Committee on Science, Space,
and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

We appreciate the opportunity to appear before you today to discuss the energy conservation and efficiency aspects of the administration's National Energy Strategy (NES), and our recent report on the Department of Energy's (DOE) energy conservation research and development (R&D) programs.

The NES established the administration's long-range blueprint for a more efficient, secure, and environmentally safe energy future for the United States and its allies. The President is legislatively mandated to prepare and submit such a plan to the Congress every 2 years.

In summary, we question whether the NES will succeed in achieving its energy efficiency goals for the following reasons:

-- The current NES is not comprehensive because it does not contain proposals that address the possibility that energy prices may remain relatively low in the future. Relatively low energy prices reduce the urgency for developing and using energy-efficient technologies. Yet, the NES relies to a large extent on the development and adoption of energy efficient technologies to reduce future energy consumption.

-- Current energy prices do not cover all of the costs to society of obtaining and using energy. For example, our heavy use of fossil fuels produces a range of adverse environmental consequences. Higher energy prices that reduce energy consumption would correspondingly reduce environmental pollution.

-- The National Academy of Sciences reported that the NES' energy policy modeling was hampered by difficulties in forecasting technological change and relatively poor data quality on energy demand.[1] These limitations raise questions about the validity of DOE's projections of the effects of implementing the NES.

In addition, we have previously reported that DOE's energy conservation R&D management and planning needed to be strengthened.[2] In this vein, we have recommended actions designed to improve DOE's energy conservation R&D planning and mandate annual independent reviews of DOE's energy efficiency R&D programs. While DOE has made planning changes that are responsive to some of our recommendations, additional planning and management actions will be necessary to fully address our concerns.

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[1] First Advisory Report: Development of the National Energy Modeling System, National Research Council, Washington, D.C. (Jan. 1991). The National Research Council is the principal operating agency of the National Academy of Sciences.

[2] Energy R&D: Conservation Planning and Management Should Be Strengthened (GAO/RCED-90-195, July 30, 1990).

POLICY APPROACHES FOR ENCOURAGING GREATER EFFICIENCY IN ENERGY USE

There are a number of ways that the government can encourage greater efficiency in energy use. For instance, policies that raise energy prices, such as taxes, can reduce the demand for energy while correspondingly increasing the demand for more efficient energy technologies. In addition, government-sponsored R&D can result in more and cheaper energy-efficient technologies being developed. The government could also require energy efficiency by placing mandatory constraints on inefficient energy use and hasten the development and use of energy efficient technologies. Finally, the government could subsidize the production or use of more efficient energy technologies.

Many of the administration's NES proposals are directed at increasing government R&D funding for energy-efficient technologies for the longer term and providing information to households and industry on energy efficient-technologies in the shorter term. For example, the NES proposes increasing industry/government cost-shared R&D on advanced battery technologies for electric vehicles and information dissemination through distribution of the "Gas Mileage Guide." However, the NES places little emphasis on the other approaches discussed earlier.

LOW ENERGY PRICES COULD JEOPARDIZE NES EFFICIENCY GAINS

The success of the NES proposals to improve energy efficiency is directly tied to the price of energy because relatively low energy prices generate less urgency to identify and implement efficient alternatives. In contrast, sustained higher prices would encourage the development and use of more efficient technologies. However, as part of the process of developing the NES, the administration considered and rejected policy measures (such as energy taxes) aimed at raising the price of energy because of their anticipated effects on the economy. In fact, higher energy prices, particularly if not phased in over time, could produce adverse economic consequences unless other offsetting policy actions are taken. In this regard, a recent Data Resources Incorporated (DRI) study[3] found that the adverse economic consequences of higher energy taxes could be offset by reducing other federal taxes. However, current low energy prices do not reflect all of the costs to society of the production and use of most fuels. For example, sustained low gasoline prices may result in decreased demand for relatively fuel-efficient automobiles, increased vehicle miles traveled, and a consequent increase in environmentally damaging emissions. The administration's approach of depending on R&D and the dissemination of information on energy-efficient technologies may not be as effective as projected if current low oil prices continue.

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[3] Review of the U.S. Economy, DRI/McGraw Hill (Mar. 1991).

Others also share this concern. For example, DOE's Oak Ridge National Laboratory reported in a background paper for the NES that, overall, price signals can strongly motivate or discourage energy-related purchases and operations. Further, the laboratory added that one primary barrier to the adoption and use of energy-efficient technologies is distorted fuel prices--prices which are too low because they do not fully reflect the environmental and social costs associated with fuels production, conversion, transportation, and use.

Similarly, the Secretary of Energy's Advisory Board reviewed the NES Interim Report and expressed concern about energy prices. The Board cautioned that if the national energy policy is going to be one of relying on market forces to determine energy choices, options to ensure that all of the costs of energy production and use are reflected in market prices (e.g., through taxes) must also be considered. Finally, the Council of Economic Advisers reported to the President that private market forces are unlikely to give adequate weight to national security and environmental considerations in setting energy prices. In summary, the market prices for energy, particularly fossil fuels, do not fully reflect all the costs of its production and consumption.

We believe that significant inroads against energy inefficiency are more likely to be realized if the price of energy better reflects all of its costs. Simply put, if American households and businesses find it in their financial self-interest to use energy efficiently, they are more likely to do so.

ANALYTICAL BASIS FOR OMITTING PRICE MEASURES AND PROJECTING ENERGY EFFICIENCY GAINS UNCERTAIN

For some time, we have been trying to obtain the administration's supporting analyses behind the NES to determine, among other things, the rationale for omitting policy measures that directly affect the price of energy. Unfortunately, the complete analytical basis for the administration's approach to achieving its energy efficiency goals has not been made available to us. Further, for some of the options that were omitted from the final NES, such as increasing vehicle efficiency standards, DOE has told us that it could be months before it provides the supporting analyses. We previously noted that the release of the detailed analyses of all options considered for inclusion in the NES would provide an important basis for informed congressional and public debate of the merits of the NES.[4]

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[4] Energy Policy: Evolution of DOE's Process for Developing a National Energy Strategy (GAO/RCED-91-76, Feb. 21, 1991).

In refining its models to perform analyses for the NES, DOE necessarily had to make numerous assumptions. For example, DOE found it necessary to make assumptions about what technologies will become available in the future and when the market will adopt them. However, when using models, even relatively small changes in assumptions can produce rather large changes in outcomes. In fact, in commenting on DOE's modeling, the National Academy of Sciences emphasized that DOE's assumptions, including assumptions on future technological choices, may very well drive the results of the models. The academy also noted the relatively poor quality of data on energy demand. For example, the Academy reported that there is little information (at DOE or elsewhere) on the potentials for energy-efficiency improvements in the industrial sector. Further, the Academy stated that "[t]he feasibility of new or alternative energy supply and some end-use technologies appear to rely on estimates made by DOE that are based on limited experience and have a documented history of over-optimism."

Because of the limited information available to us and the questionable reliability of the information used in DOE's models, it is uncertain whether DOE's projections of energy efficiency improvements resulting from the administration's NES proposals will come to pass. At the very least, policy makers should be aware of the great uncertainty associated with such projections.

PLANNING AND MANAGEMENT OF ENERGY EFFICIENCY R&D NEED TO BE IMPROVED

The NES relies to a large extent on R&D to achieve greater energy efficiency. Consequently, it is critical that DOE's energy R&D efforts prepare us for the energy scenarios we may face in the future. The administration's fiscal year 1992 conservation R&D budget request of $274 million for buildings, transportation, industrial, and utility technologies is a 28 percent increase over fiscal year 1991 funding. It should be noted that the fiscal year 1992 request is still below the $296 million[5] this important R&D program received in fiscal year 1980.

The effective use of the limited R&D funding available will depend on strong planning and management--areas in which we found problems that are discussed in our July 1990 report on the energy conservation R&D program. I would like to outline the recommendations we made for DOE to improve the conservation R&D planning and management and comment on the status of DOE's responses.

In our July 1990 report, we concluded that DOE's multi-year conservation R&D plan would be more credible and useful for management purposes if it included information on the individual projects being proposed. We also concluded that the multi-year planning process was not based on a systematic review of the individual projects by top management that would assure federal policy makers that the DOE conservation R&D portfolio reflects current needs and priorities and that outdated and/or weaker projects are terminated expeditiously. We recommended (1) that detailed program and project information be incorporated in the plan and (2) that the planning process include a systematic review of individual projects by DOE's top Office of Conservation management to help ensure that the portfolio reflects current needs. DOE has not implemented our recommendation to include information on the individual projects in the multi-year plan. In response to our recommendation for top-level reviews of individual projects, the Acting Director of the Office of Planning and Assessment in the Office of Conservation and Renewable Energy said that it would not be appropriate for the Assistant Secretary to review all conservation and renewable projects. We have continuing concerns regarding the visibility and review of individual conservation R&D projects--about 475 in 1989. We continue to believe that top management participation in reviewing individual projects and detailed program information is needed.

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[5] Nominal dollars--not adjusted for inflation.

We also found that officewide priorities based on costs and benefits could not be established because the Conservation program offices used differing methodologies to rank its proposed R&D activities. For example, the quantitative measures used by two of the offices were not compatible--one used a benefits analysis and the other used a cost/benefit analysis. We recommended that DOE use a uniform methodology so that it could prioritize its projects. The Office of Conservation and Renewable Energy is taking steps to implement this recommendation, but has not yet developed a uniform methodology.

In addition, we reported that activities needed to effectively promote the commercialization of research efforts were performed unevenly in conservation R&D programs. The most common problem we found was that DOE was not sufficiently identifying how the technologies, processes, or information would be used by the public and private sectors. We recommended that the multi-year planning process include technology transfer milestones to encourage a more systematic approach to addressing technology transfer issues. DOE has responded that technology transfer milestones will be listed in annual R&D plans. The Acting Director of the Office of Planning and Assessment in the Office of Conservation and Renewable Energy said that guidance to the R&D managers emphasizes the importance of planning for technology transfer.

We also reported that the conservation R&D planning process was not integrated with DOE's budget process. The plan produced funding estimates at only one level rather than at varying levels as is required in budget formulation and assumed the availability of unlimited funding. We recommended that DOE develop conservation

R&D plans at varying funding levels to provide a link to and support for DOE's budget process. The Office of Conservation's new multi-year plans now under development will be formulated at a number of funding levels.

Finally, we reported that although all key DOE managers cited important benefits from the independent peer review program initiated in 1985, the last such review of a conservation R&D program was conducted in 1988. We concluded that a mandate from top management was necessary to continue this program officewide. We also found that DOE's unstructured, informal responses to the peer review recommendations created uncertainties and misunderstandings among those managing and conducting the research. We concluded that more systematic, documented responses are needed to fully reap the benefits of independent assessments. We recommended that the cognizant deputy assistant secretaries be required to (1) have independent peer reviews conducted annually and (2) examine peer review recommendations as part of the Office's multi-year planning process.

The Acting Director of Conservation and Renewable Energy's Office of Planning and Assessment said he agreed with our findings and that within the next 6 months an evaluation program implementing our recommendation for mandatory independent reviews will be reestablished. He added that the workload associated with the NES process and DOE's new Strategic Planning Initiative, discussed below, has delayed the development of a new evaluation program. We are concerned with the delay in reestablishing the conservation R&D independent peer review program. We believe that evaluation and planning are equally important as each process should provide important feedback to the other. Therefore, we continue to believe that a conservation R&D evaluation program should be reactivated at the earliest possible time.

On a more comprehensive basis the Secretary of Energy has recognized the need for improvements in the Department's strategic planning process through a new strategic planning initiative. This effort, if properly implemented, should also address some of the problems we identified with DOE's conservation R&D planning.

CONCLUSION

A well-conceived and properly executed NES is important to our economic and environmental well being, and to our national security. The Nation's vision on these issues must necessarily extend well into the 21st Century if we are to be fully prepared for the alternative energy futures we may face. As such, we believe that a NES needs to consider a full range of energy efficiency and conservation policies and options and DOE's R&D efforts must be managed effectively to support the overall energy conservation/efficiency effort.

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This concludes my prepared statement. I would be glad to answer any of questions that you or other members of the Committee may have.

Judy England-Joseph is Associate Director, Energy Issues at the U.S. General Accounting Office. She oversees a broad range of GAO evaluations designed to assist the Congress in carrying out its legislative and oversight responsibilities concerning all aspects of energy matters. She has received numerous GAO honors and awards including its Meritorious Service Award.

Immediately prior to assuming her current duties, Ms. England-Joseph was working in GAO's Housing and Community Development Issues group. She has also worked with the Senate Governmental Affairs Subcommittee on Federal Services; the Deputy City Manager for the City of Pasadena, California; and HRD's Public Health and National Health Issues group.

Ms. England-Joseph joined GAO in 1975 with a Bachelor's degree in Business Administration from American University. She spent her first seven years with the Washington Regional Office and the Federal Personnel and Compensation Division, reviewing a wide range of defense, immigration, voting rights and federal personnel issues. In 1982, she became Assistant to the Director, Field Operations Division, and then Assistant to the Assistant Comptroller General-Operations, with responsibility for monitoring human resources and related operations issues.

Mr. SCHEUER. Thank you very much, Ms. England-Joseph.

I ask unanimous consent that all members be permitted to submit questions in writing.

Ms. Joseph, we're way behind schedule, and I'm going to submit a great many questions to you in writing. Your testimony was brilliant and I appreciate it very much. I'm just going to ask one or two questions and then yield to my colleague.

You raised several concerns about the adequacy of the DOE's peer review system for energy conservation program.

Ms. ENGLAND-JOSEPH. Yes.

Mr. SCHEUER. Why do you believe that independent peer reviews need to be mandated by top management?

Ms. ENGLAND-JOSEPH. I think it's very important, when you're talking about projects of this magnitude, that you have independent review by people that are not closely related to the projects themselves. I think it's important because of some of the findings that have occurred over the last several years. DOE from 1985 to 1988, I believe, had 10 independent peer reviews that they conducted. In several of those, excellent suggestions—excellent findings in terms of how projects should be improved, in some cases terminated because they had been—it appeared as though what we were finding in those projects would not be useful and additional funding was not warranted, and in some cases totally redirecting the objectives of those projects.

So those are significant issues that when those peer reviews were conducted in the past, DOE implemented those recommendations. We just feel that continued use of that kind of independent review is warranted.

Mr. SCHEUER. Can you comment on DOE's response to your recommendation that it require the conservation R&D program offices to implement independent peer reviews annually? Their recommendation—excuse me, their response to your recommendation that the DOE require the conservation R&D program offices to implement independent peer reviews annually—what did they say? What was their reaction?

Ms. ENGLAND-JOSEPH. The reaction on the part of the offices themselves?

Mr. SCHEUER. No, of the DOE at the topmost levels.

Ms. ENGLAND-JOSEPH. In many cases, I think we understand that there are a number of reasons why they feel they haven't been able to implement it. They use the National Energy Strategy, they use the fact that the Secretary has initiated a Strategy Planning Initiative that they feel will in fact improve the way the Department as a whole plans all of its R&D projects. So in many ways, they're saying that they would like to wait and see until these things are implemented, although they fully agree that some sort of independent review is warranted and an evaluation of those reviews is warranted.

Mr. SCHEUER. Well, I have grave reservations about that response on their part. I am terribly disappointed at the trashing that the Executive Branch gave to Admiral Watkins excellent proposed energy policy. I am deeply disappointed at their virtual rejection of energy conservation and energy efficiency and alternative fuels—substantial rejection of those and totally inadequate budget figures for what they did do in alternative fuels.

I feel that they really missed the boat in advocating as the answer to our Nation's problem more and more and yet even more production of fossil fuels at a time when every developed country in the world virtually without exception has its top experts cudgelling their brains and trying to find ways of reducing their production and consumption of fossil fuels to alleviate to some extent the problem of global warming.

Anyway, I'm going to direct the rest of my questions to you by mail.

Congressman Howard Wolpe of Michigan?

Mr. WOLPE. Thank you very much, Mr. Chairman.

I would like to begin by asking if Ms. England-Joseph might clarify why GAO has not been able to obtain the analyses behind the National Energy Strategy. You say that you have asked DOE for these background papers?

Ms. ENGLAND-JOSEPH. Yes, sir, we have. We've been asking for them since late October in relation to a job that we're doing for Congressman Wyden. Quite frankly, we are not sure why they aren't providing us the information. We have taken some official routes in trying to get access to those documents. Initially the reason was that the National Energy Strategy, back in October and November, of course, had not been finalized and was not yet an Administration's strategy. That was what we needed to see.

So since the National Energy Strategy has been published and now is available to everyone, we are anxious to see the supporting documentation and analyses that went into that strategy. As of early March—our last meeting with some of the key people at DOE—they told us that we would get piecemeal analyses and that the ones that we've asked for that we would most be interested in that deal with CAFE standards, taxes, transportation, conservation, energy efficiency analyses will probably be the last that we will receive because of the timing with which they're collecting all of their analyses and trying to print them.

They have told us that they're planning to publish them for the public to see, but at this point, we have not seen— we've seen very little.

Mr. WOLPE. Is there any reason that all of that material that presumably provided the backdrop for the NES should not be available to the public?

Ms. ENGLAND-JOSEPH. I should think not, unless it's not readily available. That's part of the answer we've been given, that it's not readily available, that they have to collect it from various parts of the Government, from various departments and agencies who did independent analysis as a part of supporting the strategy options.

Mr. WOLPE. Are you saying that as of this moment in time you still do not have any firm commitment that all of the material that you had requested will in fact be made available to you?

Ms. ENGLAND-JOSEPH. They have—it's interesting. They have committed that they will provide us all the analysis. The timing of when we will receive them is what is in question. We're not quite sure what it is we will actually receive.

Mr. Wolpe. I should indicate that in connection with the work of the Investigations and Oversight Subcommittee that I chair, we're having some of the same difficulty.

In your statement, you noted that today's low energy prices do not reflect the full social cost of energy production, transformation, transportation, and use. Other credible organizations are currently relaying this message.

Last week, the National Academy of Sciences issued a report on the policy implications of greenhouse warming. Can you discuss the Academy's report as it relates to your message?

Ms. England-Joseph. Yes, sir. We were pleased to see that the Academy—although their prime focus, again, was on global warming—that they did address the whole issue of identifying and addressing the full social cost of fuel. I think we all recognize that it's difficult. It's difficult to attempt to try to quantify all of the environmental costs that society has to incur with fossil fuels or other types of energy sources, as well as energy security—national security issues.

But at the same time, we're pleased that the report recognized that while it's difficult, we need to push ahead and try to determine in what way we can measure those costs so that they can be more appropriately reflected and brought apart of the decisions that you in the Congress need to make.

Mr. Wolpe. The full social cost pricing is obviously an issue of the day. There seems to be a national movement to recognition of that.

Mr. Scheuer. I have a question of information. When you say full social costs, do you mean including environmental, the cost of remediating that?

Mr. Wolpe. That's correct.

Mr. Scheuer. Thank you.

Both DOE and White House staff include some very well trained and knowledgeable members who must be cognizant to this question. What is your view as to why they did not develop a National Energy—or why they developed a National Energy Strategy which does not include measures to assign to energy it's full social and environmental cost?

Ms. England-Joseph. We don't know why. It's stated several times throughout the Strategy itself that the DOE recognizes the impact of pricing and the fact that higher prices will in fact have a direct relationship to energy efficiency or other types of marketplace behaviors. A number of people, as you have noted, have in fact endorsed the need for full social pricing, but it's not clear because of the lack of analyses—or at least readily available analyses—by DOE to determine why they decided not to include serious options in their National Energy Strategy that would attempt to at least address that, or begin to address it.

Mr. Wolpe. We understand that the GAO, in addition to reviewing the National Academy of Sciences' report and DOE's NES modeling, has spoken with a member of the Committee that wrote that report. Did he provide information beyond that provided in the Academy's report?

Ms. England-Joseph. Yes, sir, he agreed with our statements concerning DOE's modeling and the limited demand data that's available. But I think more significantly, he strongly agrees with our concern about technological choice and that in fact from the outset, assumptions were brought to bear in terms of whatever outcomes came out of those modeling exercises and that predicting technological choice is not something the models were designed to do, but in fact the effects of the assumptions affected that technological outcome.

Mr. WOLPE. So in other words, we may—that in some respects the kinds of projections and recommendations for energy R&D investments, for example, might be of a nature of self-fulfilling prophecies, where we are kind of creating technological scenarios rather than——

Ms. ENGLAND-JOSEPH. Allowing the models to create them.

Mr. WOLPE. That's right.

And my last question—we've heard many complaints that the NES does more to promote traditional supply options rather than conservation and efficiency measures. Do you feel that the public wants and would support policies designed to promote conservation?

Ms. ENGLAND-JOSEPH. Yes, sir. I think if there was anything that came out of the National Energy Strategy's interim report, which of course was the basis of numerous public hearings and a number of written comments that the DOE received from the public and from industry, "the single loudest message"—and that's a quote from their report—"the single loudest message was to increase energy efficiency in every sector of energy use." Again, it is not clear to me why we don't see more of the energy efficiency and conservation issues that the public has called for in the NES itself, but clearly the public has stated that that is something that we need to address.

Mr. WOLPE. Thank you very much.

Mr. SCHEUER. Thank you, Congressman Wolpe.

I'm going to take just another minute or two. We're inquiring as to whether Michael Davis, Assistant Secretary of the DOE for conservation and renewables, will be able to make this hearing. He isn't here now. Apparently he is appearing before the Appropriations Committee. So since he isn't here—and if he doesn't come back, we're simply going to put his testimony in the record.

We're going to wait a few minutes, so I'm going to take a few minutes that I didn't think I would have to ask you a few questions, but I will still submit a number of questions by mail.

I would like to ask you, on behalf of Congressman Wolpe and myself, to give us a report or a memo on the various ways, the various legislative approaches that we could take to get social and environmental costs cranked into our energy costs across the board. Which do you think are most cost effective and feasible and will have the least discomfort?

There are some brave souls around here that say that what we ought to do is have an energy tax of perhaps $1 a gallon and we could work up to that over a period of years—perhaps 10 cents a year for 10 years—so that the impact in the first few years would be comparatively modest, but people in buying new cars would have for a number of years as the tax grew and grew inexorably—

from their point of view—it would concentrate their mind on thinking about energy efficient cars.

And it would also concentrate the mind of the automobile industry that energy efficient cars would have a growing appeal each year as this tax bite grew. So they would have some confidence that if it cost $600, $700, or $800 as we understand to produce a one-third increase in energy efficiency for cars—we've had that testimony in the prior panel—were you here for the prior panel?

Ms. ENGLAND-JOSEPH. Yes, sir.

Mr. SCHEUER. You probably heard that.

They would feel a degree of comfort in the knowledge that the $600, $700, or $800 that it would cost to produce a car that consumed only two-thirds as much energy would pay for itself in a very short period of time.

So you might react to that now, and if you want to tell Congressman Wolpe and myself off the cuff what some of the options are, that's fine, but maybe you could take a week or 10 days and give us a thoughtful memo. But respond now briefly.

Ms. ENGLAND-JOSEPH. We would be happy to respond to you formally. There are several options and clearly one of them is a gasoline tax. I think in many ways you have described the pro side in terms of what are the advantages of the gas tax in terms of reduced consumption and possibly the more deliberate decision on what type of auto to purchase.

Mr. SCHEUER. But there's also a pro side that each year that we increase the tax 10 cents, we would get an extra $10 billion a year into the Federal Treasury over what we had the year before.

Ms. ENGLAND-JOSEPH. Yes, sir that's a big plus.

Mr. SCHEUER. That's a real big plus.

Ms. ENGLAND-JOSEPH. Part of my discussion about the cons, or the disadvantages, actually deal with the revenues as a fix, I believe, where the revenues end up being the fix.

Many people argue that a gasoline tax in fact hurts the people that can least afford to deal with higher prices, and/or companies that may be affected because they're more service oriented and use fuels for their transportation and distribution systems. But an energy tax—in fact, the revenues could either be deficit reducing, or they could be deficit neutral in the sense that you put back in those revenues in other aspects of society, whether it be to lower personal income tax, lower corporate income tax, possibly reduce employee payroll taxes.

So there are a number of other options that in fact balance out the economic effect, or you can in fact increase weatherization programs, or increase the energy efficiency assistance for low income families.

Mr. SCHEUER. Energy conservation research programs.

Ms. ENGLAND-JOSEPH. Certainly.

So there are a number of ways in which you can balance out some of the negatives that we've often heard about increasing a gas tax. But clearly the one that is probably the most attractive to many on the Hill is the deficit reduction side. Certainly for an increase in the tax—that would do that.

Mr. SCHEUER. But you will give Congressman Wolpe and me a memo?

Ms. ENGLAND-JOSEPH. We'd be happy to do that.

Mr. SCHEUER. The next question. You heard in that first panel the enormous potential of savings in buildings due to better lighting, more fuel efficient heating, more fuel efficient air condition, more fuel efficient motors, generators, whatnot. How do we quantify the benefit and value of energizing the Federal Government? How do we quantify the impact they would have on that market out there as a role model? How do we quantify the impact they would have——

Ms. ENGLAND-JOSEPH. I think they would have a significant impact.

Mr. SCHEUER. Wait a minute. Let me finish—in getting products and systems that are now in the developmental stage into the production stage? How do we quantify all that? Then part b of this question is, How do we energize the Federal Government to play that tremendously important role?

Ms. ENGLAND-JOSEPH. I don't know that I can quantify it. I don't know that anybody really can. But the bottom line is that if the Government took an active approach, an aggressive leadership approach in doing to itself what we perhaps would like to see other people do, it would certainly reduce energy consumption in the Nation significantly.

But the bigger issue, of course, is how do we get people to move, to act? How do we get the Government to act? It really does end up being a cost issue in many regards.

In the course of our work, we talked to a number of people that are in pro-conservation, pro-energy efficiency, but when we asked them what kinds of energy efficiency technologies they have in their homes, they don't have them. A lot of it is because of the price associated with it, and the ease with which you can buy that technology. You can't buy it at Hechingers. You can't buy a light bulb that's more energy efficient tha incandescent light bulbs. If you can find it, it's like $20 or $30. Most of the people are not willing to pay that initial cost even if in the long run they spend less on energy.

Some of the issues that we see at the consumer level very clearly are also faced at the Federal Government level. If they're constrained by Federal budgets, perhaps, the cost associated with that large increase in investment may be something that they look in the short term and say that it's not worth the investment. But we would probably beg them to look to the long term because in the long term there is a significant advantage.

Mr. SCHEUER. Well, as I understand it, many of these investments have a very short payout period of 2 or 3 years.

Ms. ENGLAND-JOSEPH. As we heard this morning, yes, sir, that's what we have heard. That's what we have seen. Again, I can't quantify, because I haven't done the work, to tell you exactly what kind of results that would have in terms of actual energy costs if the Government were to implement them.

Mr. SCHEUER. Well, could you give us an analysis of major conservation investments in the field, let's say, of building management and give us a rough approximation, a thumbnail approximation, of the payout period? We may then question the Federal Government and say, "If you could save hundreds of millions of dollars or billions of dollars' worth of energy every year, and you get a 2 to 3 year payout"— I'll just pull those figures out of the air—"How can you afford not to make this investment?"

An additional payout would be the role model effect, the stimulative effect that that would have on other private real estate people. Real estate is not owned by and large in very large agglomerations—billions of dollars' worth of real estate. The major Fortune 500 companies, mostly manufacturing, sales, communication, so forth are not real estate. Office buildings are generally held in small ownership groups that own maybe one or several buildings.

These folks are less well-informed than the Federal Government is, they have less capital available than the Federal Government does, they have a higher cost of borrowing money, and they generally have a shorter range viewpoint in terms of how fast the return on their investment ought to be and how soon they ought to get their money out.

If we can't convince the Federal Government, with its access to capital, with its long term viewpoint, to make these investments, how can we expect the average building owner, who may own one or two office buildings—how can we expect him to make that if the Federal Government won't make that decision?

Ms. **England-Joseph**. It's my understanding that the Administration has drafted an Executive Order, which we have not yet seen, but proposes a 20 percent reduction in energy use in Federal buildings by 1995.

I think your question is an excellent one for Mr. Davis in terms of what thought went into the 20 percent. Is that optimistic? Is it realistic? How would that actually be achieved? Would it address some of the issues you're talking about in terms of the substantial gains that it appears could be made available if the technologies we heard about this morning were implemented.

Mr. **Scheuer**. One last question. You heard this morning about the joint venture between Ford, General Motors, and Chrysler on the development of an electric automobile battery—of an improved battery for an electric car. I guess you would call that applied research. You also heard discussion of the tremendous potential of further research in friction engineering, overcoming friction in moving vehicles.

Would that formula be an appropriate formula for friction research? In other words, for the three automobile companies to get together and do that jointly? Or is there some other approach? Is this more logically research and pure science that universities should do, or that the Federal Government ought to do itself or contract for?

Apparently it's an important area of research that hasn't been met. How do we deal with that?

Ms. **England-Joseph**. I think that the advantages of the joint venture that was described is that probably independently they would not have done it alone, but together they——

Mr. **Scheuer**. You're talking about the electric batteries?

Ms. **England-Joseph**. The electric batteries.

Mr. **Scheuer**. Right.

Ms. **England-Joseph**. In fact, that might be the way to approach the friction technology issue. If individually no one company or no one university is interested in doing that type of research, collectively perhaps there may be a better opportunity for that research to go, not just from the R&D slate, over to actual tech transfer and actual commercial use. I think that's the key, getting a buy-in of major industries so that when they've done the research they actually see a purpose for it that they can immediately use rather than research just for research and to that end.

Mr. **SCHEUER**. Thank you.

Congressman Wolpe, do you have any further questions you would like to ask?

Mr. **WOLPE**. No, Mr. Chairman.

Mr. **SCHEUER**. The record will be left open for questions to be submitted by mail.

I thank this panel and this witness. You were absolutely splendid and we look forward to receiving the information that we discussed.

Ms. **ENGLAND-JOSEPH**. Thank you, sir.

Mr. **SCHEUER**. Incidentally, we haven't been able to pry Michael Davis loose from Appropriations, so his DOE testimony will be published in the record and the Subcommittee will submit questions to Mr. Michael Davis for the record based on his testimony.

[The prepared statement of Mr. Davis follows:]

Statement of J. Michael Davis
Assistant Secretary, Conservation and Renewable Energy
U.S. Department of Energy
Before the
Committee on Science, Space, and Technology
Subcommittee on Environment
Wednesday, April 17, 1991

Mr. Chairman and members of the Committee, I am pleased to present the Administration's Fiscal Year 1992 budget request of $326 million for Energy Conservation programs.

This request reflects the renewed commitment that the Department of Energy is giving to energy efficiency research and development. Last year, in a notable departure from recent history, we proposed an R&D budget that was more than double the previous year's request. Congressional action resulted in FY 1991 funding that was 21 percent higher than in FY 1990. This year's request continues that trend with a proposed increase of 27 percent above last year's appropriation. It sharpens the focus of an already successful program, by emphasizing our most promising technologies and accelerating our effort in them.

As part of the effort to sharpen our focus, we have reorganized the Office of Conservation and Renewable Energy. The new organization is built around the four end-use sectors--Buildings, Industry, Transportation, Utilities--and an Office of Technical and Financial Assistance. These sectors represent our customers. Our intent is to make our programs more market- and results-oriented, bringing supply and demand issues together in ways that make internal management and external communication easier and more consistent.

BATTERY CONSORTIUM

We think our approach is starting to pay dividends. For example, in the area of transportation technologies, our effort to target the most promising battery alternatives has led to the formation of the U.S. Advanced Battery Consortium. A partnership agreement was signed by Ford, General Motors, and Chrysler on January 30 to conduct a major multi-year research and development effort to develop advanced batteries. The participants consider this agreement to be a major milestone in their efforts to bring electric vehicles to market and regain an international competitive edge.

In recent years, battery performance has improved, but it remains the principal deterrent to the larger use of electric vehicles. The consortium intends to:

- Accelerate the market potential of electric vehicles by jointly researching the most promising advanced battery alternatives;
- Develop electrical energy systems capable of providing electric vehicles with range and performance competitive to petroleum-based vehicles; and
- Pool funding for high-risk, high-cost advanced battery research and development for electric vehicles.

The consortium plans to propose a cost-shared program to DOE, with 50 percent of the funding to be provided by the automobile, utility, and battery industries. A tentative selection of battery candidates will be reviewed by technical working groups. Our request for FY 1992 is $27 million, up from $9 million for battery research in FY 1991.

WASTE MINIMIZATION

In the area of industrial technologies, we are focusing our efforts on what we call waste minimization and what EPA calls pollution prevention. U.S. industry produces about 12 billion tons of waste each year. The cost of handling, cleaning, and disposing of these wastes is $45 billion per year and rising rapidly. As much as 9 quads of energy annually is contained in the embodied energy of unused or poorly used raw materials, in the energy content of the waste streams, and in the energy required to clean up and dispose of wastes. EPA's regulations tend to focus on end-of-the-pipe cleanup, rather than technological change to eliminate waste streams altogether. The DOE program, planned and cost-shared with industrial partners, will develop process technologies which reduce generation of all forms of wastes.

The budget request for the Industrial Wastes program ($16.7 million) is a substantial increase over the $4.1 million appropriated in FY 1991. Roughly half of it will go for new efforts to: (1) improve data on industrial wastes; (2) build partnerships between national laboratories and industry (together with other DOE offices where appropriate), focusing on toxic wastes produced in chemical processes; (3) develop new technologies to reduce waste generation; (4) distribute information to encourage use of waste-reducing technologies; and (5) analyze regulatory barriers to industrial waste reduction.

Recently EPA offered $1 million, to be matched by DOE, for State grants in support of this last objective--identifying and eliminating regulatory barriers to waste-minimizing technology that can accomplish the same results as end-of-the-pipe pollution control. The initial project(s) will focus on mutually selected States and industries and will be funded and administered through DOE regional support offices.

EFFICIENCY STANDARDS

In the area of building technologies, minimum efficiency standards are an effective way to induce conservation. The life-cycle cost savings of more efficient equipment (from reduced energy use) generally exceed the increased purchase costs. Without standards, buyers often opt for a lower first cost, particularly when the buyers (e.g., builders, landlords) are not the users (homeowners, tenants). Efforts to set standards must therefore balance efficiency goals with consumer costs.

Appliance standards can result in considerable economic and energy benefits to consumers and the Nation. This month the Department expects to issue a final rule for revised appliance standards on dishwashers, clothes washers, and clothes dryers, to take effect in 1994. The standards will require the manufacture of appliances that are 14 to 30 percent more energy efficient than those required by current standards. These standards will result in an estimated $2.3 billion in reduced energy costs to consumers and a cumulative energy savings of 2.25 quads from 1994 to 2015.

Testing and standards development and evaluation are a very complicated and time-consuming process, and we need to expand our effort and capabilities in this area. Our budget requests a 26 percent increase, to $2.5 million, in support of the appliance standards requirements and development of efficiency labeling for lighting.

In the area of building standards, mandatory standards have been issued for Federal buildings. A proposed rule concerning voluntary standards for non-Federal residential buildings will be published this summer. Our budget request includes $3 million to encourage the adoption of these standards nationwide. We received no appropriation for this aspect of our standards program last year, but we are using $600,000 in reprogrammed FY 1990 funds to cooperatively develop training materials for building industry and code officials.

In addition, Congress last year required HUD to set minimum efficiency standards for all new Federally supported and assisted housing (including homes bought with FHA mortgages). HUD has agreed to rely on us to provide the technical support for these standards.

INTEGRATED RESOURCE PLANNING

In the area of utility technologies, integrated resource planning, or least-cost utility planning, has come into its own as a way to plan and acquire energy resources at the least total cost, promoting the full and fair competition of all supply-side and demand-side resources options to meet energy service needs. A key objective is the elimination of market impediments, such as:

- Preferential regulatory treatment for supply investments vs. investments in energy efficiency.
- The first-cost value placed on energy efficiency by equipment buyers (e.g., builders, landlords) who are not the end users who pay the utility bills (home buyers, tenants).

Pursuant to the National Energy Strategy, we plan to encourage the adoption of integrated resource planning by providing information and technical assistance to utilities, State utility regulators, and other stakeholders. A budget increase from $3 million to $5 million is requested for this purpose. The power marketing administrations also will promote its adoption by their customer utilities, and FERC will be encouraged to promote its adoption through the regulation of wholesale power sales.

STATE AND LOCAL GRANTS

The final building block of our organization is the Office of Technical and Financial Assistance, which includes all of what used to be called the

State and Local Assistance Program, as well as several discrete information and technology transfer activities previously scattered among the R&D programs. We are seeking no new appropriations for the State grant programs this year, other than the amount expected to be available under the Petroleum Overcharge Distribution and Restitution Act (PODRA), but I want to assure you that we are committed nonetheless to the support of State energy conservation and weatherization efforts.

As you know, since 1983, the States have received more than $4.2 billion in restitutionary funds from petroleum overcharge violations; more than $2.2 billion remain unexpended. The States can also expect to receive as much as $400 million more over the next three years. We recognize that the amounts still available vary from State to State and in some cases have been allocated to other purposes. We recognize also that the formula used to distribute these funds is not related to the formulas that DOE uses to distribute program grant funds. However, since these funds are available to the States and can be spent for these purposes, and given our budget limitations, we could not justify a higher priority for these grant funds than for our programs of research and development.

Our staff will continue to work with the States to provide technical assistance as the States continue to develop and implement their energy conservation programs. We will also continue to work with the States to assure that oil overcharge funds are expended in accordance with the provisions of the court settlements. Finally, we have requested $30 million from the Federal share of oil overcharge funds under PODRA for grants to the States, including $10 million to encourage innovative approaches in weatherization assistance, particularly in attracting non-Federal resources to the program. Attracting such funds, as for example through utility programs developed through an integrated resource planning process, will strengthen the long-term vitality of the program.

Now I will discuss a few additional highlights from the budget request for our principal program offices.

BUILDING TECHNOLOGIES

Our budget request for the Office of Building Technologies is $54.2 million, up 26 percent from last year's level of $43.1 million. An additional $1 million is contained in the Energy Supply R&D request for the Solar Buildings program.

Although there have been dramatic improvements in energy efficiency in this sector during recent years, the rate of improvement seems to be slowing, and energy use is growing rapidly--an increase of 1.4 quads from 1987 to 1989. Our goal is to develop cost-effective technologies to reduce energy loads in new buildings by 30 percent in the near term, 55 percent in the mid term, and 80 percent in the long term.

o In the Lighting and Appliances program, we plan to accelerate development of advanced, high-efficiency lighting and to initiate a research program for commercial building appliances and advanced appliance technologies.

- In the Buildings Systems Research program, in addition to the building standards work already mentioned, we will begin to build and test a prototype system for computer-aided design of energy-efficient commercial buildings. We will also expand our support for energy-efficient industrialized housing, and we will work with HUD to encourage efficiency in public housing projects, combining our technical assistance and HUD incentives.

- In the Federal Energy Management program, we will be strengthened by a forthcoming Executive Order on Federal energy management, and we plan to expand our already successful effort to attract utility interest in retrofitting Federal facilities. Four major (and several smaller) Federal/utility collaborations to date will result in as much as $100 million of investment in exchange for DOE technical assistance.

INDUSTRIAL TECHNOLOGIES

Our budget request for the Office of Industrial Technologies is $101.9 million, up 22 percent from last year's level of $83.5 million. An additional $9.4 million is contained in the Energy Supply R&D request for Solar Thermal and Biofuels Energy programs. The program's goals are to develop technology that improves industrial process energy efficiency and fuel flexibility, while reducing or productively using waste streams.

- The Municipal Solid Waste program continues activity previously funded under the Energy Supply R&D account. The economic and productive use of municipal waste, primarily as a source of electricity, is constrained by environmental and economic concerns. To encourage MSW conversion to energy where appropriate, energy, economic and environmental data are needed to compare bioprocessing, recycling, and landfill alternatives. Research is also needed to develop new or improved technologies that are cleaner and less expensive in order to expand both waste-to-energy and recycling markets. The budget request of $6.3 million would support these efforts.

- We have brought forward a new request this year for Electric Drives. Approximately 70 percent of the electric power consumption in industry is used to drive electric motors. As much as 1.5 quads could be saved through the use of adjustable speed drives and high-efficiency motors. We have requested $500,000 to identify and investigate technical barriers to the use of such motors and drive systems.

- In the Materials Processing program, our request includes a slight increase for the Metals Initiative, but a reduction overall. Congress last year appropriated $2 million for a metal casting research program and $3 million for an "integrated manufacturing information system." These activities do not appear to offer as much potential benefit as competing projects, and therefore no funding has been requested for their continuation. The Metals Initiative budget includes superplastic steel processing ($1.2 million); (2) spray forming of steel ($2.2 million); (3) direct steelmaking ($9.6 million); and (4) aluminum cell cathode development ($0.9 million). We have also asked for $4 million to respond to new opportunities.

- In the Implementation and Deployment area, we have asked an additional $1.5 million to increase the number of Energy Analysis and Diagnostic Centers. This university-based industrial audit program expanded from 13 to 16 schools in November 1990; two more will be selected for funding in 1991. Our request would bring the number to 22, as we move toward a program goal of 40 schools and nationwide coverage by the year 2000.

TRANSPORTATION TECHNOLOGIES

Our budget request for the Office of Transportation Technologies is $111.2 million, up 33 percent from last year's level of $83.8 million. An additional $29.4 million is contained in the Energy Supply R&D request for Biofuels Energy programs. The focus of the Transportation activities within the Energy Conservation account is the development of cost-effective improvements in vehicle fuel efficiency.

- In the Alternative Fuels Utilization program, a significant increase is asked to support the acquisition and operation of fleet vehicles as required by the Alternative Motor Fuels Act of 1988.

- Increases are also asked in our substantial Materials Development and Heat Engine Development programs, though we will once again seek increased cost-sharing on development of ceramic components for an automotive gas turbine.

- In the Implementation and Deployment area, a large increase is requested to support creation of four university-based Alternative Fuels Research Centers of Excellence, one for each potential fuel--ethanol, methanol, natural gas, and reformulated gasoline. We also propose creation of a fellowship program for U.S. graduate students at the High-Temperature Materials Laboratory.

TECHNICAL AND FINANCIAL ASSISTANCE

Our budget request for the Office of Technical and Financial Assistance is $48.3 million. An additional $4 million is contained in the Energy Supply R&D request in support of renewable technologies. The program's goal is to encourage adoption of conservation and renewable energy technologies and practices at the State and local levels through a mix of technical and financial assistance. Most importantly, we are moving aggressively with our network of support office personnel in the field to improve our communication and cooperation with the States.

- We are requesting $2 million in a new category, Joint Ventures, to engage with the States in industry-driven joint ventures to accelerate the deployment of energy efficiency and renewable energy technologies.

- In the Information and Communication area, we are requesting additional funding to expand and improve our information sharing with other energy officials and with the public, while consolidating various existing assistance services.

SUMMARY AND CONCLUSIONS

Mr. Chairman, in conclusion, we are proposing a balanced yet aggressive program in energy conservation. My comments today have touched only briefly on the major elements of the budget, but I am sure you can see we have some very promising activities under way. We are gearing up our program to help implement the National Energy Strategy, and together with our program in renewable energy, we are investing in critical components of our energy future.

I appreciate your time and attention, and I would be pleased at this time to answer any questions you may have.

Thank you very much.

Mr. **Scheuer**. I thank the witnesses.

The hearing is adjourned at the call of the Chair.

[Whereupon, at 4:05 p.m., the committee adjourned, to reconvene at the call of the Chair.]

FISCAL YEAR 1992 AUTHORIZATION FOR THE DEPARTMENT OF ENERGY'S ENERGY CONSERVATION PROGRAM

TUESDAY, APRIL 23, 1991

House of Representatives,
Committee on Science, Space, and Technology,
Subcommittee on Environment,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. Scheuer. The Environment Subcommittee of the House Science, Space, and Technology Committee will come to order.

Today we will review the progress of an important energy conservation program at the Department of Energy called the "Metals Initiative."

Testimony we will receive today will establish the legislative record needed to reauthorize this program, which has already yielded multiple benefits to society.

In the mid-1980s, Congress recognized that the troubled steelmaking industry needed a boost to stay competitive in the global marketplace. In 1985, the Committee on Science, Space, and Technology sponsored legislation providing DOE with $7.5 million to work with the steel industry; to investigate energy conservation measures in steel production. The "Steel Initiative," as it was called then, was deemed so successful by Congress that in 1988, budget authority for the program was passed into law as Public Law 100-680, The Steel and Aluminum Energy Conservation and Technology Competitiveness Act. With the addition of aluminum and copper, the program was redubbed the "Metals Initiative."

The Act authorized spending by the DOE, as well as the National Institute for Standards and Technology, for fiscal years 1989 through 1991. The Act requires industry participation and matching funding. Companies choosing to participate can significantly benefit, partly by maintaining patent rights to technological developments.

The potential energy savings from the commercial application of technologies developed under this program are enormous. For example, widespread application of just one of the program's projects, "direct" steelmaking, would reduce overall energy consumption by 20 percent, saving a fifth of a "quad"—that's a quadrillion—of British Thermal Units.

Just for the record, a fifth of a "quad" is equal to almost one-half of one percent of the total energy consumed in our country in a year. That's a very substantial energy saving.

Another project, to develop a modified electrolytic process for making aluminum, could save as much as a tenth of a "quad."

This program is a shining example of the benefits that can be accrued from cooperative research between Government and the private sector.

I am looking forward to hearing from our distinguished witnesses here today about the important research that the Metals Initiative has made possible and what that will mean to our society.

[The prepared opening statement of Mr. Scheuer follows:]

OPENING STATEMENT

THE HONORABLE JAMES H. SCHEUER

SUBCOMMITTEE ON ENVIRONMENT

HEARING ON

STEEL AND ALUMINUM RESEARCH FOR ENERGY CONSERVATION

APRIL 23, 1991

Today we will review the progress of an important energy conservation program at the Department of Energy called the "Metals Initiative."

The testimony received today will establish the legislative record needed to reauthorize this program, which has already yielded multiple benefits to society.

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In 1985 the Committee on Science, Space and Technology sponsored legislation providing DOE with $7.5 million to work with the steel industry to investigate energy conservation measures in the production of steel.

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The Act requires industry participation and matching; companies choosing to participate can benefit significantly, partly by maintaining patent rights to technological developments.

The potential energy savings from the commercial application of technologies developed under this program are enormous.

For example, widespread application of just one of the program's projects -- "direct" steelmaking -- would reduce overall energy consumption by 20 percent, saving a fifth of a quadrillion British Thermal Units, commonly known as a quad.

For perspective, a fifth of a quad is equal to almost half a percent of the total amount of energy consumed in one year in this nation.

Another project, to develop a modified electrolytic process for making aluminum, could save as much as a tenth of a quad.

This program is a shining example of the benefits that can be accrued from cooperative research between government and the private sector.

I am looking forward to hearing from our distinguished witnesses here today about the important research that the Metals Initiative has made possible.

RECOGNIZE OTHER MEMBERS; REMIND WITNESSES THAT IN ORDER TO PERMIT QUESTIONS BY THE MEMBERS, THEY SHOULD LIMIT THEIR PRESENTATIUON TO FIVE MINUTES AND THEIR FULL WRITTEN STATEMENT WILL BE ENTERED INTO THE RECORD.

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Mr. SCHEUER. I would like now to yield to the ranking minority member of this subcommittee, Congressman Don Ritter of Pennsylvania, who has a very extensive and in-depth background in the steel industry, and whose guidance we look to when it comes to treating the subject of steel in almost any way.

Congressman Ritter?

Mr. RITTER. Thank you so much, Mr. Chairman, and I want to commend you for holding this hearing on an important part of our national energy conservation effort.

Steel, Mr. Chairman, is still our preeminent engineering material, and steel and aluminum are vital materials with a central place in our economy. The steel and aluminum industries are simply too basic to our nation's economy and security to let them fall any further from their once most competitive position in the world marketplace. This is particularly true in view of the intense pressures they feel from government-supported foreign competitors.

Then, there is the human side. In the Lehigh Valley of Pennsylvania, I have seen firsthand what the erosion of the steel industry can mean to an entire community.

For our purposes in this Subcommittee, energy conservation goes hand-in-hand with economic competitiveness. Today the steel and aluminum industries are surviving by improving the quality of their process and their products, while undergoing painful restructuring. The Metals Initiative in the Department of Energy can play a role in the rebirth of these industries in their new, more competitive stance. Research in the steel and aluminum industries, as we will hear from the witnesses today, can help achieve energy savings while providing enhanced productivity, and environmental benefits.

Recently, scientists at Lehigh University, in my Congressional district, demonstrated the potential of such research. Working with support from the American Iron and Steel Institute, AISI, under the "Direct Steelmaking Project," Dr. Yong Kim has developed a laser-produced plasma sensor unit, essentially a way to measure the process of forming steel faster and more accurately than ever before. The sensor unit, according to one consultant, is a definite step forward that could help steelmakers save as much as $200 million each year. And this also adds to the ability of steel to conserve energy by making the shapes more accurately and with less energy use in the forming process.

This ground-breaking research began back in 1984, with a push from this Committee, Mr. Chairman. In 1984, I participated in an ongoing discussion, along with Jay Keyworth, who was then the President's Science Advisor, Secretary of Energy Don Hodel, key staff from the Federal agencies represented here today, and steel industry experts, to try to use the expertise of the Federal laboratories to help tackle steel industry problems.

I remember well the initial meeting out at Argonne National Laboratories. The result of that effort was H.R. 4416, the bill which former Pennsylvania Representative Doug Walgren and I introduced in 1986 to enhance steel industry competitiveness. That bill was the direct predecessor of the legislation which became Public Law 100-680, which the chairman referred to, the Steel and Aluminum Energy Conservation and Technology Competitiveness Act.

That law of 1988 formally reestablished the "Steel Initiative," which had been ongoing at the Department of Energy since 1985. The law gave direction to the program and authorized funding through this fiscal year, 1991.

Our task today is to determine how to continue the involvement of the Federal Government in the public-private sector partnership that has blossomed under the Metals Initiative. Ground-breaking research is well underway, and the first promising results are apparent. Still, as we will hear from our witnesses, we will find out that the R&D process has only begun, and now is no time to let up.

We will hear from witnesses today from the Department of Energy and the National Institute of Standards and Technology on ongoing research to aid the steel and aluminum industries. We will also hear from witnesses from each of the exciting projects in progress under the Metals Initiative:

The "Direct Steelmaking" project, a series of technologies designed to eliminate some of the major steps of traditional steelmaking, has enormous potential for energy savings and environmental benefits;

The "Superplastic Steel" project, which has as its goal the creation of a steel which is strong and tough, yet easily shaped into finished parts. Superplastic steel could yield great savings in the amount of scrap or steel which is discarded in the process of manufacturing parts, plus, in the energy required to form steel. Thus, it would lead to decreased volume of scrap, lower energy consumption, and overall major energy savings;

The "Spray Forming" project, designed to literally allow steelmakers to spray molten steel onto a base to form strip steel; and

The so-called "Wettable Cathode" project in the aluminum industry, with substantial potential for decreasing the very large amount of electricity consumed by the Commercial Aluminum Reduction Cell.

With the exception of the aluminum project, which has just commenced, all of the Metals Initiative projects are moving well along in the research and development phase. Still, much more work is necessary before the new technology can be commercially available. On the horizon, there are even more exciting initiatives which could be funded under the Metals Initiative, such as the recent proposal to use intelligent manufacturing and processing to computerize and automate the manufacturing process.

Continuing this vital program, with its potential positive impact on energy conservation and use of scarce raw materials, could be a major boost to two important industries, and save a lot of energy for America in the process. Like so many of the projects in the Department of Energy's conservation program, the work done under the Metals Initiative has the potential to pay for itself many times over in energy savings and improved productivity. Once again, these two go hand-in-hand.

I am pleased to work with you, Mr. Chairman, to assure the continuation of the Metals Initiative, and I welcome input from our witnesses, our distinguished witnesses, today on the appropriate way to accomplish that goal.

Thank you, Mr. Chairman.

[The prepared opening statement of Mr. Ritter follows:]

OPENING STATEMENT
HON. DON RITTER (R-PA)
HEARING ON STEEL AND ALUMINUM RESEARCH
APRIL 23, 1991

THANK YOU, MR. CHAIRMAN. I WISH TO COMMEND YOU FOR HOLDING THIS HEARING ON AN IMPORTANT PART OF OUR NATIONAL ENERGY CONSERVATION EFFORT.

STEEL IS STILL OUR PREEMINENT ENGINEERING MATERIAL, AND STEEL AND ALUMINUM ARE VITAL MATERIALS WITH A CENTRAL PLACE IN OUR ECONOMY. THE STEEL AND ALUMINUM INDUSTRIES ARE TOO BASIC TO OUR NATION'S ECONOMY AND SECURITY TO LET THEM FALL ANY FURTHER FROM THEIR ONCE-MOST COMPETITIVE POSITION IN THE WORLD MARKETPLACE. THIS IS PARTICULARLY TRUE IN VIEW OF THE INTENSE PRESSURES THEY FEEL FROM GOVERNMENT-SUPPORTED FOREIGN COMPETITORS.

THEN, THERE IS ALSO THE HUMAN SIDE. IN THE LEHIGH VALLEY OF PENNSYLVANIA, I'VE SEEN FIRSTHAND WHAT THE EROSION OF THE STEEL INDUSTRY CAN MEAN TO AN ENTIRE COMMUNITY.

TODAY, THE STEEL AND ALUMINUM INDUSTRIES ARE SURVIVING BY IMPROVING THE QUALITY OF THEIR PROCESS AND THEIR PRODUCTS, WHILE UNDERGOING PAINFUL RESTRUCTURING. THE "METALS INITIATIVE" AT THE DEPARTMENT OF ENERGY HAS PLAYED A ROLE AS WELL IN THE VIRTUAL REBIRTH OF THESE INDUSTRIES. RESEARCH IN THE STEEL AND ALUMINUM INDUSTRIES, AS WE'LL HEAR FROM OUR WITNESSES TODAY, CAN HELP ACHIEVE ENERGY SAVINGS, ENHANCED PRODUCTIVITY, AND ENVIRONMENTAL

BENEFITS.

RECENTLY, A SCIENTIST AT LEHIGH UNIVERSITY, IN MY CONGRESSIONAL DISTRICT, DEMONSTRATED THE POTENTIAL OF SUCH RESEARCH. WORKING WITH SUPPORT FROM THE AMERICAN IRON AND STEEL INSTITUTE (AISI), UNDER THE "DIRECT STEELMAKING PROJECT", DR. YONG KIM HAS DEVELOPED A LASER-PRODUCED PLASMA SENSOR UNIT, ESSENTIALLY A WAY TO MEASURE THE PROCESS OF FORMING STEEL FASTER AND MORE ACCURATELY THAN EVER BEFORE. THE SENSOR UNIT, ACCORDING TO ONE CONSULTANT, IS A "DEFINITE STEP FORWARD" THAT COULD HELP STEELMAKERS SAVE AS MUCH AS $200 MILLION EACH YEAR!

THIS GROUND-BREAKING RESEARCH BEGAN BACK IN 1984, WITH A PUSH FROM THIS COMMITTEE. IN 1984, I PARTICIPATED IN AN ONGOING DISCUSSION ALONG WITH JAY KEYWORTH (WHO WAS THEN THE PRESIDENT'S SCIENCE ADVISOR), SECRETARY OF ENERGY DON HODEL, KEY STAFF FROM THE FEDERAL AGENCIES REPRESENTED HERE TODAY, AND STEEL INDUSTRY EXPERTS, TO TRY TO USE THE EXPERTISE OF THE FEDERAL LABORATORIES TO TACKLE STEEL INDUSTRY PROBLEMS.

A RESULT OF THAT EFFORT WAS H.R. 4416, THE BILL WHICH FORMER REPRESENTATIVE DOUG WALGREN AND I INTRODUCED IN 1986 TO ENHANCE STEEL INDUSTRY COMPETITIVENESS. THAT BILL WAS THE DIRECT PREDECESSOR OF THE LEGISLATION WHICH BECAME PUBLIC LAW 100-680, THE STEEL AND ALUMINUM ENERGY CONSERVATION AND TECHNOLOGY COMPETITIVENESS ACT OF 1988. THAT LAW FORMERLY REESTABLISHED THE

"STEEL INITIATIVE," WHICH HAD BEEN ONGOING AT THE DEPARTMENT OF ENERGY SINCE 1985. THE LAW GAVE DIRECTION TO THE PROGRAM, AND AUTHORIZED FUNDING THROUGH FISCAL YEAR 1991.

OUR TASK TODAY IS TO DETERMINE HOW TO CONTINUE THE INVOLVEMENT OF THE FEDERAL GOVERNMENT IN THE PUBLIC-PRIVATE SECTOR PARTNERSHIP THAT HAS BLOSSOMED UNDER THE "METALS INITIATIVE." GROUND-BREAKING RESEARCH IS WELL UNDERWAY, AND THE FIRST PROMISING RESULTS ARE APPARENT. STILL, AS WE'LL HEAR FROM OUR WITNESSES, THE R&D PROCESS HAS ONLY BEGUN, AND NOW IS NO TIME TO LET UP.

TODAY WE WILL HEAR FROM WITNESSES FROM THE DEPARTMENT OF ENERGY AND THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY ON ONGOING RESEARCH TO AID THE STEEL AND ALUMINUM INDUSTRIES. WE WILL ALSO HEAR FROM WITNESSES FROM EACH OF THE EXCITING PROJECTS IN PROGRESS UNDER THE METALS INITIATIVE:

-- THE "DIRECT STEELMAKING" PROJECT, A SERIES OF TECHNOLOGIES DESIGNED TO ELIMINATE SOME OF THE STEPS OF TRADITIONAL STEELMAKING, WITH ENORMOUS POTENTIAL FOR ENERGY SAVINGS AND ENVIRONMENTAL BENEFITS;

-- THE "SUPERPLASTIC STEEL" PROJECT, WHICH HAS AS ITS GOAL THE CREATION OF A STEEL WHICH IS STRONG AND TOUGH, YET EASILY SHAPED INTO FINISHED PARTS. SUPERPLASTIC STEEL COULD YIELD

SAVINGS IN THE AMOUNT OF SCRAP OR STEEL WHICH IS DISCARDED IN THE PROCESS OF MANUFACTURING PARTS, THUS LEADING TO DECREASED VOLUME AND, THEREFORE, ENERGY SAVINGS;

-- THE "SPRAY FORMING" PROJECT, DESIGNED TO LITERALLY ALLOW STEELMAKERS TO SPRAY MOLTEN STEEL ONTO A BASE TO FORM STRIP STEEL; AND

-- THE "WETTABLE CATHODE" PROJECT IN THE ALUMINUM INDUSTRY, WITH GREAT POTENTIAL FOR DECREASING THE LARGE AMOUNTS OF ELECTRICITY CONSUMED BY THE COMMERCIAL ALUMINUM REDUCTION CELL.

WITH THE EXCEPTION OF THE ALUMINUM PROJECT, WHICH HAS JUST COMMENCED, ALL OF THE METALS INITIATIVE PROJECTS ARE MOVING WELL ALONG IN THE RESEARCH AND DEVELOPMENT PHASE. STILL, MUCH MORE WORK IS NECESSARY BEFORE THE NEW TECHNOLOGY CAN BE COMMERCIALLY AVAILABLE. ON THE HORIZON, THERE ARE EVEN MORE EXCITING INITIATIVES WHICH COULD BE FUNDED UNDER THE METALS INITIATIVE, SUCH AS THE RECENT PROPOSAL TO USE INTELLIGENT PROCESSING TO COMPUTERIZE AND AUTOMATE THE MANUFACTURING PROCESS.

CONTINUING THIS VITAL PROGRAM, WITH ITS POTENTIAL POSITIVE IMPACT ON ENERGY CONSERVATION AND USE OF SCARCE RAW MATERIALS, WOULD BE A TREMENDOUS BOOST TO TWO IMPORTANT INDUSTRIES. LIKE SO MANY OF THE PROJECTS IN THE DEPARTMENT OF ENERGY'S ENERGY CONSERVATION PROGRAM, THE WORK DONE UNDER THE METALS INITIATIVE HAS THE

POTENTIAL TO PAY FOR ITSELF MANY TIMES OVER IN ENERGY SAVINGS AND IMPROVED PRODUCTIVITY. I AM PLEASED TO WORK WITH YOU, MR. CHAIRMAN, TO ENSURE THE CONTINUATION OF THE METALS INITIATIVE, AND I WELCOME INPUT FROM OUR WITNESSES ON THE APPROPRIATE WAY TO ACCOMPLISH THAT GOAL.

Mr. SCHEUER. All right. Let's commence with the first panel.

Let me tell all the witnesses here today that we are a little bit pressed for time. We have a very large second panel, and we are going to ask the witnesses to give us an overview of their prepared testimony in five minutes. Your prepared testimony will be printed in full in the record at the point at which you testify, so your oral testimony shall be a summary of your testimony, plus any reference you want to make to anything you have heard here this morning, either from my colleague or myself, or from other witnesses.

So we will start out with you, Mr. Alan J. Streb, Deputy Assistant Secretary for Industrial Technologies at the U.S. Department of Energy, Washington, DC.

Please proceed, Mr. Streb.

STATEMENT OF HON. ALAN J. STREB, DEPUTY ASSISTANT SECRETARY FOR INDUSTRIAL TECHNOLOGIES, U.S. DEPARTMENT OF ENERGY

Mr. STREB. Thank you, Mr. Chairman and Mr. Ritter. I appreciate the opportunity to be before you today to discuss the status of the Department's program on the Metals Initiative. My complete statement has been offered for the record and I will summarize it very briefly.

The program began with the "Steel Initiative" which emerged after Dr. Keyworth, who was President Reagan's Science Advisor, suggested that a program of increased collaboration between the National Laboratories, the universities, and industry could help improve the competitiveness of the steel industry.

Subsequently, the 1986 Interior Appropriations Act provided $7.5 million for the Department for a research and development initiative to increase significantly the energy efficiency of processes that produce steel, thus providing the first Federal funding for the Steel Initiative. The act also required some cost-sharing participation by industry.

In 1988 this initiative was expanded with the passage of The Steel and Aluminum Energy Conservation and Technology Competitiveness Act, which created the Metals Initiative, to enhance the efficiency and competitiveness of the American steel and aluminum and copper industries. This act also specified certain obligations of the industry and the Department of Energy with respect to cost-sharing, ownership of information, planning, and reporting.

In 1989 the Department of Energy issued management and research plans as required by the act.

A total of $47 million has been appropriated through fiscal year 1991 for the Steel and Metals Initiative programs. Of this amount, over $39 million has been identified for obligation to seven projects. I will touch on the four research and development projects currently underway.

The first project, Superplastic Steel Processing, has a goal of developing a steel composition and processing sequence to produce superplastic steel on a production scale. Superplasticity is a phenomenon whereby the alloy can be deformed in large amounts without fracturing. Recent work has identified new steel compositions and processing sequences that are expected to yield acceptable superplastic behavior. Work is currently underway to cast these new steels continuously, then forge the commercial component. There is potential to reduce energy consumption and costs as a result of reduced machining required to finish the component.

The second project, Spray Forming of Steel, has a goal to develop near net shape processes for the production of low carbon steel sheet. Liquid steel is gas-atomized into a spray, which is propelled in a gaseous atmosphere and deposited onto a substrate to form a thin strip. Successful development would significantly reduce energy consumption and eliminate several processing steps from the conventional flatrolled steel production flow sheet. Phase 1 work, in which several spray nozzle designs were developed and tested at bench scale, is nearing completion, and a proposal for the second phase of this program is currently being prepared.

The third project, Direct Steelmaking, has a goal to develop a coal-based energy-efficient process that has significant potential for reduction in liquid steel production costs and energy intensity. Successful development will eliminate the use of metallurgical coke in the production of liquid steel from ore. As you know, the production of metallurgical coke is an environmentally burdensome process, and the steel industry has given high priority to its elimination.

Pilot-scale process development of a single zone smelter is currently being conducted by the American Iron and Steel Institute. Operation of the pilot plant has been highly successful, and attention is now focused on the design and construction of a two-zone smelter, which is expected to increase productivity.

The fourth project, Aluminum Cell Cathodes, which is the first project actually established under the Metals Initiative, has a goal of developing wettable titanium diboride cathode technology for the Hall-Heroult alumina reduction cell. Successful development would reduce the operating gap between the cathode and the anode, thereby significantly improving the energy efficiency of the alumnina reduction process.

More details on these projects are included in the testimony and in the recent annual report on The Steel and Aluminum Energy Conservation and Technology Competitiveness Act.

The Department is currently negotiating a financial assistance award for the development of direct strip casting and the rapid analysis of molten metal. In addition, proposals for the development of intelligent processing of steel and the dezincing of steel scrap are currently being evaluated.

Our research and development plan has identified other areas of technological opportunity which have not yet been addressed under the Metals Initiative.

A holding company concept for the management of intellectual property has been implemented and appears to be meeting its objectives. This mechanism is intended to facilitate the transfer of information to the marketplace and provide benefits to project participants. The two holding company agreements signed to date include provisions for the recoupment of Federal funds expended in the development of successful technologies.

In summary, the Metals Initiative program is achieving the goals set by Congress, and no major changes are needed. Industry interest is high and new proposals continue to be received. Indeed, we believe that the Federal investment could be further leveraged by increasing the level of cost-sharing from 30 percent to, perhaps, 50 percent.

Effective public-private research and development partnerships have been established that also involve National Laboratories.

Thank you for this opportunity to present our program. I would be pleased to address any questions that you have now.

[The prepared statement of Mr. Streb follows:]

STATEMENT OF ALAN J. STREB

Deputy Assistant Secretary for Conservation

U.S. Department of Energy

before the

Subcommittee on Environment

Committee on Science, Space and Technology

U. S. House of Representatives

April 23, 1991

Mr. Chairman and Members of the Committee, I appreciate this opportunity to appear before you today to provide a status report on the Department of Energy's Metals Initiative Program. The program that I will describe to you is directed toward development of new and improved technologies that will contribute to the energy efficiency of the metals industry far into the 21st century. In this endeavor, we have worked closely with the metals industry and believe that we have an aggressive program, responsive to the needs of industry.

As you know, the Steel Initiative originated from a White House report prepared in 1983. Commonly referred to as the Packard Report, it recommended increasing collaboration of the National Laboratories with universities and industry. Subsequently, Dr. George Keyworth, Science Advisor to President Reagan, and other members of the President's Committee on Industrial Competitiveness suggested that this recommendation could be translated into a program to improve the competitiveness of the U.S. steel industry.

Subsequently, the 1986 Interior Appropriations Act included a provision that $7.5 million be made available through the Department of Energy (DOE) "for a research and development initiative...to increase significantly the energy efficiency of processes that produce steel." The obligation of these funds was contingent upon an agreement by industry "to provide cash or in-kind contributions...equal to 30 percent of the amount of Federal Government obligations."

In 1988, this initiative was expanded by the Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988. This Act, Public Law 100-680, has the following purposes: to "increase the energy efficiency and enhance the competitiveness of American steel, aluminum, and copper industries..."; and to continue the research and development efforts begun under the Steel Initiative. As required by the Act, management and research plans were developed. In 1989, over 600 copies of these plans were mailed to personnel in the steel, aluminum, and copper industries, labor organizations, National Laboratories, universities, other research organizations, independent consultants, and other interested parties.

Since the initial funding of the Steel Initiative in July 1986, a total of $47,167,000 has been appropriated through FY 1991 for both the Steel and the Metals Initiative programs. Of this amount, $39,168,000 has been obligated to, or identified for obligation, through April 23, 1991, as follows:

Electromagnetic casting	$ 2,184,000	(Discontinued)
Superplastic steel processing	2,206,000	(Underway)
Spray forming steel	5,908,000	"
Direct steelmaking	25,669,000	"
Aluminum cell cathodes	910,000	"
Direct strip casting	1,891,000	(In negotiation)
Rapid analysis of molten metal	400,000	"
TOTAL	39,168,000	

We anticipate that the balance, $7,990,000, will be obligated during FY 1991, to a combination of Phase II of the spray forming project, aluminum cell cathodes, and to the initiation of new projects, currently under review.

I would now like to present a brief description of our current research and development activities. We have four research and development projects actively under way: (1) superplastic steel processing, (2) spray forming steel, (3) direct steelmaking, and (4) aluminum cell cathodes. In addition, DOE has made commitments to fund proposals on single wheel casting of steel strip and on a rapid analysis of molten metals using a laser probe.

Superplastic steel processing was initially funded in March 1988. This project is managed by Lawrence Livermore National Laboratory (LLNL) and is cost-shared by three industrial partners: North Star Steel Co.; Ladish Co.; and Caterpillar, Inc. The overall objective of the project is to develop a steel composition and a steel processing sequence to produce superplastic steel on a production scale. Superplasticity is a phenomenon exhibited by some metals and alloys whereby the metal or alloy can be deformed in large amounts without fracturing, thereby facilitating production of complex components by, for example, forging. Energy savings are estimated at about 0.01 quads (quadrillion Btus) annually, primarily through improved yield; significant cost savings through elimination of machining are also anticipated.

Phase I was completed in FY 1990 and led to the development of a steel with excellent die-filling capabilities; however, the techno-economic analysis showed a need to improve superplastic behavior for economic viability. Phase IIA was initiated in June 1990 to achieve this goal.

Recent laboratory work has identified steel compositions and processing sequences that should result in improved superplastic behavior. Work is currently under way to cast these new steels continuously and then forge a commercial component. Subsequently, the techno-economic analysis will be updated.

Spray forming steel was first funded in March 1989. This project is managed by the Idaho National Engineering Laboratory (INEL) and includes laboratory efforts at INEL, Oak Ridge National Laboratory (ORNL) and the Massachusetts Institute of Technology (MIT). Cost-sharing is provided by several industrial participants, including Chaparral Steel, Air Products and Chemicals Company, A.O. Smith, and Haynes International. The objective is to develop a near-net-shape casting process for production of low-carbon steel sheet in which the energy- and capital-intensive process steps of slab casting, reheating, and hot rolling would be partially or completely eliminated. It is estimated that the energy saving potential of spray forming and other direct strip casting processes, when applied to all sheet and strip products, is at least 0.2 quads annually.

The spray forming program is divided into two phases, in which the technology development moves from bench-scale (Phase I) to pilot-scale (Phase II). The Phase I work, which is very close to completion, will provide a basis for the decision to proceed to a Phase II pilot-scale facility.

Three different nozzle concepts have been pursued in Phase I by INEL, ORNL, and MIT. Steel has been sprayed through each nozzle design, and the steel product is being evaluated. In addition, INEL has developed the diagnostic capability to measure the temperature, velocity, and size of individual drops within the spray plume; INEL has also developed a one-dimensional process model and the elements of a process control system.

The Phase II proposal for construction of the pilot plant, in a commercial steel facility, utilizing one or more of the nozzle designs, is anticipated to be delivered in the near future.

Direct steelmaking was first funded in May 1989. The project is being managed and cost-shared by the American Iron and Steel Institute (AISI). The primary objective of this project is to develop a coal-based, energy efficient, less capital-intensive, economically competitive, direct steelmaking process that will eliminate the need for metallurgical coke and its associated environmental problems. The direct steelmaking program involves construction and operation of a smelting pilot plant, plant tests of post combustion and foaming slag concepts in an existing basic oxygen furnace, and laboratory-scale research at Carnegie Mellon University and MIT. When commercially implemented, the process is expected to reduce liquid steel production costs and has the potential to save about 0.2 quads annually.

Construction of the pilot-scale smelting facility utilizing a vertical vessel was completed in May 1990, and the experimental program is expected to be completed by end of June 1991. The full-scale post-combustion and slag foaming tests were completed in FY 1990, and the university research is proceeding satisfactorily; both are being integrated into the experimental work at the pilot plant. Operation of the pilot plant has been highly successful and demonstrated the viability of in-bath smelting in conjunction with a high level of post combustion. Based on these results, a novel smelter design involving a two-zone, countercurrent furnace has been proposed to increase productivity. A half-scale water model has been constructed and is being used to study process kinetics. The process engineering of the two-zone smelter is basically complete, and subcontracts for engineering and fabrication have been let.

The Aluminum cell cathodes project is the first for the aluminum industry and the first project funded under the Metals Initiative. (The prior three projects were initiated, and have continued, under the Steel Initiative.) The project was initiated early in FY 1991 and is managed by Reynolds Metals in collaboration with Great Lakes Research Corporation. The project is a logical extension of previous bench-scale research funded by DOE. The objective of the work is to develop wettable titanium diboride cathodes and associated cell designs and control systems for the Hall-Heroult alumina reduction cell.

In present Hall-Heroult cells, the instability of the liquid aluminum surface requires a large gap between the cathode and anode to avoid short circuiting. The use of wettable cathodes will allow this gap to be decreased, resulting in a significant decrease in the voltage difference between the anode and cathode, thereby improving energy efficiency. An estimated 0.1 quads would be saved annually with cathode retrofits of all domestic alumina reduction cells.

As part of this three-year project, two commercial alumina reduction cells will be redesigned, and titanium diboride graphite cathodes will be fabricated and then tested under commercial operating conditions. To date, design modifications to the cell and control systems have been completed, and procedures for fabrication of cathodes have been initiated. Testing is scheduled to begin in December 1991.

Direct strip casting is designed to cast carbon steel strip directly on a single, water-cooled wheel. DOE is currently negotiating a financial assistance award with Armco, Inc. The successful development of this near-net-shape casting process would lead to the production of cold rolled steel sheet in which the requirements for slab casting machines, reheat furnaces, and hot-strip rolling mills would be eliminated. Like spray forming, this is a high-risk research area that has a potential for significant energy, capital, and operating cost savings. Direct strip casting would share energy savings of about 0.2 quads annually with the spray forming project.

Rapid analysis of molten metal is a project proposed by Lehigh University and cost-shared by the AISI. DOE is currently negotiating a financial assistance award. The objective of this project is to develop a laser probe to provide rapid elemental analysis of molten iron and steel. Energy savings, primarily in the form of yield improvement and increases in productivity, have been estimated at 0.01 quads annually. Significant cost savings are also anticipated. In addition, this technology will find application in other metal industries.

Based on current project plans, excluding Phase II of the spray forming steel project, the cumulative outyear mortgage for existing projects is:

FY 1992	$14,633,000
FY 1993	2,750,000
FY 1994	543,000

We also currently have proposals under evaluation to address the areas of automated processing and related sensor technology and scrap beneficiation (an AISI proposal on intelligent processing and a proposal on dezincing of steel scrap).

With regard to possible future directions of the Metals Initiative program, let me refer you to the Metals Initiative Research Plan, which was published in May 1989 and which accurately reflects the needs of the industry even today. The objective of this plan was to identify and establish priorities for research and development opportunities that can increase the energy efficiency and enhance the competitiveness of the domestic steel, aluminum, and copper industries.

Finally, I would like to address our experience with the holding company concept. As you know, it is DOE's intention to immediately transfer title of all resulting technology from this program to a holding company selected by the project's participants. This method of handling intellectual property is intended to serve the dual purposes of facilitating technical transfer to the market place and providing benefits to project participants. Four financial assistance awards have been made to date, and two holding company agreements have been signed. AISI has formed Steel Technologies Inc., and the participants in the superplastic steel project have designated the University of California as its holding company; both entities have signed agreements with DOE that include provision for recoupment of the government's investment. The participants in the spray forming project are in the final stages of negotiation with DOE on a holding company agreement. Only initial discussions have been held with the participants in the recently initiated, aluminum cell cathode project.

To date, the effectiveness of the holding company concept for facilitating technology transfer has not been ascertained because the projects have not progressed to the technology transfer stage. However, DOE is confident that the holding company concept is both a viable and practical means for handling intellectual property, particularly when multiple participants are involved.

In summary, it is fair to say that the Metals Initiative program is achieving the goals set by Congress. The provisions of the underlying statute remain sound, and no major changes are needed. Industry interest is high, and new proposals continue to be received. Indeed, we believe the Federal investment could be further leveraged by increasing the level of cost sharing required from 30% to 50%. Effective public-private sector research and development partnerships have been established that also involve National Laboratories and academia.

DOE has worked closely with the National Institute of Standards and Technology (NIST). An example is the workshop on Intelligent Processing for Primary Metals, held in Gaithersburg, Maryland, in August 1989, that was attended by more than 80 participants, primarily from the steel, aluminum and copper industries.

Thank you for this opportunity to testify. I would be pleased to address any specific questions you may have at this time.

STEEL AND ALUMINUM ENERGY CONSERVATION AND TECHNOLOGY COMPETITIVENESS ACT OF 1988

RESEARCH PLAN

Office of Industrial Programs
Office of Conservation and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

May 1989

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I. EXECUTIVE SUMMARY

The Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988 was signed by President Reagan on November 17, 1988. This Act has the following purposes:

(1) to "increase energy efficiency and enhance the competitiveness of American steel, aluminum and copper industries...," and

(2) to continue steel research and development efforts begun under the DOE program known as the Steel Initiative.

The Act directs the Secretary of Energy to "reestablish an industrial energy conservation and competitive technology program to conduct scientific research and development of steel and aluminum technologies to carry out the purposes of this Act," to "publish an update of the management plan" and to "publish an update of the research plan." The term "research plan" means the Steel Initiative Research Plan issued in April 1988 by the Department of Energy. To develop the updated Research Plan, the April 1988 Plan has been modified to reflect the intent of Congress as indicated in the Act and committee reports; aluminum and copper have been included and information has been added in the steel area. The updated Plan thus identifies and establishes priorities for research and development opportunities that can increase the energy efficiency and enhance the competitiveness of American steel, aluminum and copper industries. The Management Plan required by the Act will be published separately by DOE.

In formulating the Research Plan all major process areas where preliminary analysis suggests there is an opportunity to increase energy efficiency and enhance competitiveness have been analyzed. In addition, other areas suggested by the 1988 Act have been considered in consultation with industry.

For steel, ore-based steelmaking and near-net-shape casting are high opportunity areas where clearly defined research and development opportunities exist with large potential benefits to the steel industry. Automated processing technology, which includes the development of sensors, is also an area with large potential benefits. Scrap beneficiation and thermomechanical processing are areas of opportunity where research and development programs have been defined but potential benefits are less than in ore-based steelmaking and near-net-shape casting. The development of a direct steelmaking process and near-net-shape casting processes may offer the best approach to address environmental problems. Although no specific opportunities have been defined in the finishing area, opportunities exist, particularly through the development of automated processing technology and sensors. In both the scrap-based steelmaking and the universal grade of steel areas, recent advances have reduced research and development opportunities.

For aluminum, the production of aluminum from alumina via the Hall-Heroult cell technology is the highest opportunity process area, where clearly defined research and development opportunities exist; the development of retrofit technologies will significantly increase energy efficiency and enhance competitiveness. Near-net-shape casting of flat rolled products is also a high opportunity area with clearly defined benefits and research and development programs. The automated processing technology area, including the development of sensors, should be considered an opportunity area with significant benefits. The recycling, remelting and refining area offers opportunities to improve energy efficiency and enhance competitiveness through the development of new technologies to recover aluminum from scrap and improve yield during remelting. There is probably some opportunity to increase energy efficiency and enhance competitiveness in the alumina production area, and in the manufacture of both cast and mill products areas and in the environmental area; however, it is difficult to envision that projects in these areas can have a major impact on the energy efficiency and competitiveness of the aluminum industry.

For copper there is an opportunity to develop new and improved technologies for the extraction of copper from domestic ores. A specific opportunity is the application of solvent extraction and electrowinning technologies to *in situ* ores.

Development of the Research Plan is a dynamic process. DOE will continue its extensive, informal contacts with the American metals industry -- producers, equipment manufacturers and suppliers -- and the research community. The Plan will be periodically circulated for formal industry comment; promising research areas will be incorporated into the Plan as appropriate.

II. RESEARCH PLAN OBJECTIVE

The objective of this Research Plan is to identify and establish priorities for research and development opportunities that can increase the energy efficiency and enhance the competitiveness of the domestic steel, aluminum and copper industries.

III. GENERAL INTRODUCTION

The Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988 was signed by President Reagan on November 17, 1988. This Act, Public Law 100-680, hereinafter referred to as the "Act," has the following purposes:

(1) to "increase energy efficiency and enhance the competitiveness of American steel, aluminum and copper industries...," and

(2) to continue steel research and development efforts begun under the DOE program known as the Steel Initiative.

The Act directs the Secretary of Energy to "reestablish an industrial energy conservation and competitive technology program to conduct scientific research and development of steel and aluminum technologies to carry out the purposes of this Act." To provide a framework for program implementation and to fulfill the requirements of the Act, a Management Plan has been developed. The intent of Congress, as indicated in the Act and committee reports, as well as DOE policies and operating practices have been considered in developing the Management Plan.

The Act also directs the Secretary to "publish an update of the research plan." The term "research plan" means the Steel Initiative Research Plan issued in April 1988 by the Department of Energy. To develop the updated Research Plan, the April 1988 plan has been modified to reflect the intent of Congress as indicated in the Act and committee reports; aluminum and copper have been included and information has been added and revised in the steel area. The updated Plan thus identifies and establishes priorities for research and development opportunities that can increase the energy efficiency and enhance the competitiveness of the domestic steel, aluminum and copper industries.

No attempt has been made to identify research and development opportunities in metals industries other than steel, aluminum and copper. In general, the other metals industries are significantly smaller than steel, aluminum and copper in terms of tons produced and energy consumed. An exception is the iron foundry industry, which produces 10 million tons of castings and consumes 0.2 quadrillion Btu per year. The energy consumed in the iron foundry industry is similar to that consumed by the copper industry and about one tenth of that consumed by the steel industry. Although this research plan does not address opportunities in metals industries other than steel, aluminum and copper, this does not imply that research and development projects for other metals industries, such as the foundry industry, lack the potential to fulfill the purposes of the Act.

To accomplish the previously stated objective, the following methodology was developed. Project areas are first defined in terms of the conventional process area or combination of process areas that are replaced or improved by emerging technologies. Using available cost data, the value added can be calculated for each process area. The value added is defined as the cost of processing minus the cost of inputted materials that have been processed by the industry in a previous process area. Capital charges are not included in the value added determinations. An estimate of the portion of the value added that can be eliminated by research and development efforts allows prioritization of the process areas based on potential achievable benefits.

The Research Plan is divided into three sections - steel, aluminum and copper. The development of the plan is a dynamic process. DOE will continue its extensive, informal contacts with domestic steel, aluminum and copper industries, including steel, aluminum and copper producers, equipment manufacturers and suppliers and the research community. Contacts will also be made with other metals industries. The Plan will be periodically updated.

IV. STEEL RESEARCH PLAN

A. INTRODUCTION

The Steel Initiative Research Plan was issued by the Department of Energy in April 1988. This plan is consistent with FY 1986 through FY 1988 Federal budget appropriations and the April 1987 Steel Initiative Management Plan. In this plan, an analysis of selected steel manufacturing process areas within the steel process flow sheet was conducted to determine those areas that merit most serious consideration for research and development consistent with the goals of the Steel Initiative Program. Of the six manufacturing processes areas selected for analysis, near-net-shape casting, scrap beneficiation (which is part of the raw materials preparation area) and thermomechanical processing were viewed as areas of opportunity for the development of leapfrog technology. In the iron-making area, it was concluded that there was a clearly defined need to develop a lower cost, less capital intensive and more flexible process that uses coal as the reductant; it was also concluded that development of a new process in this area faces difficult technical and economic hurdles. In the scrap-based steelmaking and hot-metal-based steelmaking process areas, new processes are in the late stage of development and some have been commercialized. Consequently, it was concluded that the opportunity to develop new leapfrog technologies in the scrap-based and hot-metal-based steelmaking process areas was lower than in the other areas.

Although the April 1988 Steel Initiative Research Plan serves as a basis for the updated plan, the methodology developed and the data obtained by Battelle under contract to DOE will be used to assist in identification and establish priorities for research and development opportunities that will enhance the energy efficiency and technology competitiveness of the domestic Steel Industry. As stated previously, process areas are first defined in terms of the conventional process area or combination of process areas that are replaced or improved by emerging technologies. Some areas, such as ore-based steelmaking, combine processing areas -- raw materials preparation, ironmaking, cokemaking and steelmaking -- whereas other process areas either replace or improve only one process area.

Using the cost data obtained by Battelle[1], the value added can be calculated for each process area. In general, a large value added in a process area implies that there may be a corresponding high opportunity to improve energy efficiency and enhance competitiveness. The actual opportunity to fulfill the requirements of the Act will depend on a number of factors, including the energy consumed in the process area, the status of emerging technologies and an identification and estimate of the benefits that can be obtained by research and development efforts.

The steel process flow sheet is complicated, and division of the flow sheet into process areas is to some extent subjective. In formulating the Steel Research Plan, all the process areas or combination of process areas have been analyzed where preliminary analysis suggests there is an opportunity to increase energy efficiency and enhance competitiveness. In addition, other areas suggested in the Act have been considered. Some of these areas, such as automated processing technology, could affect all process areas in the steel flow sheet, from ore to finished product and extending to customer service and steel scheduling. Other process steps, such as coatings, which is included in the finishing area, are small in terms of value added but could lead to opportunities to enhance technology competitiveness through the development of new and improved steel products.

Based on the above considerations, the following process areas have been identified and analyzed:

- Ore-based Steelmaking
- Scrap-based Steelmaking
- Scrap Beneficiation
- Near-Net-Shape Casting
- Thermomechanical Processing
- Universal Grades of Steel
- Automated Processing Technology
- Finishing (including Coatings)
- Environmental

Notes

(1) Final Report on "Supporting Development of the DOE Steel Research Initiative" to EG&G Idaho, Inc., February 1989.

B. ORE-BASED STEELMAKING

Background

About 60 percent of the steel produced in the U.S. is made by the basic oxygen process and about 40 percent by the electric arc furnace process. The predominant source of iron units in the basic oxygen furnace is hot metal produced from ore; however, the charge also contains between 20 and 30 percent scrap. In 1987, 52 million tons of raw steel were produced by the basic oxygen process; total raw steel production was 89 million tons.

The current ore agglomeration/coke oven/blast furnace/oxygen steelmaking suffers a number of disadvantages as compared with electric arc furnace melting of scrap steel. First, the ore-based steelmaking route is capital intensive, requiring huge outlays for agglomeration plants, blast furnaces, coke ovens and oxygen steelmaking shops. Second, the process requires more than twice the amount of energy to produce a ton of steel as compared with the energy required by an electric arc furnace melting a 100 percent scrap charge.[1] Third, the process is most efficient when operated with large facilities at high utilization rates, but this operational condition limits the flexibility to accommodate variations in demand, characteristic of the steel economic cycle.

The value added in the ore-based steelmaking area, which is a combination of several process areas including pelletizing and sintering of ore, cokemaking, ironmaking and steelmaking, is estimated to be over $5 billion per year. The ore-based steelmaking area is also energy intensive, consuming about 1 quadrillion BTU per year. Thus, research and development in the ore-based steelmaking area has enormous potential to improve energy efficiency and enhance competitiveness through the development of an alternate steelmaking process.

Replacement of the current capital intensive facilities for the production of pellets, sinter, coke and liquid iron with a single-step process that uses coal rather than coke as the reductant, could result in considerable capital and operating cost savings. Energy savings could also be considerable. Over 60 percent of the energy consumed by the domestic steel industry occurs in the process steps culminating in the production of liquid steel. A 10 percent savings in energy equates to about 0.1 quadrillion BTU per year.

Research Opportunity

In general terms, two process options exist:

> Option One -- To develop a new ironmaking process that avoids the agglomeration plant, blast furnace, coke oven portion of the processing route, while maintaining the basic oxygen process for conversion of hot metal (liquid iron) to liquid steel.

Option Two -- To develop a direct steelmaking process that will replace the agglomeration plant, blast furnace, coke oven *and oxygen steelmaking process*, and convert unagglomerated iron ore to liquid steel on a continuous basis.

Current Status

In response to the need for an alternate ironmaking process, a number of new processes have been developed over the past two decades. In general, these processes aim to be less capital intensive, more economical and less polluting than the current blast furnace/coke oven technology.

The most advanced of these ironmaking processes in terms of process and engineering development is Corex which is a coal-based process that can use lump ore, pellets or sinter as the source of iron units and a wide range of coals. No coke is required. A 300,000 TPY plant was commissioned in early 1988 in South Africa. Problems were encountered and operations were suspended for several months while modifications were made. The plant is now back in operation but results are not available.

The status of new ironmaking processes has been summed up in a recent paper by Smith and Corbett[2] in which they state the following:

> *It has been found that the new coal-based ironmaking processes have a significant economic advantage where new investment is planned to replace completely old iron works or to undertake a very major rebuild at an old ironworks, to expand capacity in an existing works, or to form the basis of a new mini-steelworks. However, they are not economic to replace existing capacity or to avoid refurbishing modern iron works.*

In addition to new coal-based ironmaking processes, there are several blast furnace modifications that aim to enhance coal injection into the blast furnace. Smith and Corbett state that *"processes which aim to enhance coal injection into the blast furnace are economically feasible options to avoid purchasing coke or rebuilding coke ovens."* They also recommend that where the steel industry is committed to the blast furnace for the foreseeable future because of previous investment, coal injection technological development be given priority.

There is undoubtedly a tremendous incentive, both in the United States and abroad, to develop either a new ironmaking process or a new steelmaking process that is less capital intensive, has lower operating costs and is less polluting than that based on the current blast furnace/coke oven technology. The Europeans and Japanese have active programs aimed at development of such a process; details of these programs are not available. Furthermore, there is broad agreement that development of a new process should concentrate on in-bath smelting of iron ore using coal as the fuel.

To obtain further information in this area the American Iron and Steel Institute (AISI) formed a task force in 1987, which was charged with the responsibility for (1) assessing worldwide trends in the development of direct steelmaking processes and (2) preparing a program of research and development to facilitate the rapid implementation of direct steelmaking by the domestic steel industry. As a result of these activities, AISI submitted a proposal to DOE in July 1988 to develop a continuous steelmaking process. The proposal contains the following elements for development: (1) in-bath smelting of iron ore pellets and fine ore in a continuous process that uses coal as the fuel, (2) effective transfer of the heat from post combustion to the bath and use of the process gases for preheating and prereduction of the ore, (3) flexibility to use both iron ore and scrap as charge materials to the smelter, and (4) continuous desulfurization and decarbonization of the metal from the smelter. DOE has accepted this proposal for negotiation of a financial assistance award under the Steel Initiative program.

Conclusion

The ore-based steelmaking process area is a high opportunity area. There is a clearly defined need and opportunity to develop a new process that converts unagglomerated iron ore or pellets to liquid iron (or liquid steel) using coal as a reductant, with significant reductions in capital expenditures and operating costs.

A proposal from the AISI has been accepted for negotiation of a financial assistance award under the Steel Initiative program. Acceptance of this proposal does not imply that other proposals in the ore-based steelmaking process area are excluded from consideration for funding.

Notes

(1) R.J. Fruehan, "Alternate Scrap Melting Technologies, Part I," *Iron and Steelmaker*, March 1987.

(2) R.B. Smith & M.J. Corbett, "Iron & Steelmaking," Vol. 14, No.2, p. 49, 1987.

C. SCRAP-BASED STEELMAKING

Background

Scrap-based steelmaking, defined as processes that utilize 100 percent (or close to 100 percent) scrap charge is dominated by the electric arc furnace. This process exhibits significant economic advantages over the coke oven/blast furnace/oxygen steelmaking route in terms of capital and energy requirements, production costs and flexibility.[1,2] It is not surprising, therefore, that production from electric arc furnaces in the U.S. has almost doubled during the last decade, reaching almost 40 percent of total production in 1988; predictions are for further increases in the next few years. In 1987, 34 million tons of steel were produced in electric arc furnaces. The value added in the scrap-based steelmaking process area, which excludes the cost of scrap, is estimated to be about $2 billion per year.

Electric arc furnace steelmaking technology has undergone significant changes during the last 25 years.[1] Tap-to-tap times have decreased from over three hours to close to one hour and furnace productivities of over 100 tons per hour are now attainable. Installation of ultra-high power furnaces, water cooled panels in the roof and sidewalls, oxygen blowing, oxy-fuel burners, scrap preheating and ladle metallurgy have all reduced the time to produce steel; these improvements are considered to be proven technology. It has been estimated that if existing advances in equipment and process technologies were installed on all the electric arc furnace plants in the U.S., the output would be increased by 50 percent.[2] Such an increase in production is dependent, of course, on the ability to overcome both upstream and downstream bottlenecks.

Despite the advances in electric arc furnace steelmaking, considerable efforts are being expended to develop alternate equipment and processes to lower both the production and/or capital costs of scrap-based steelmaking. Replacement of the three-phase AC electric arc furnaces with either DC arc, plasma or induction furnaces and the development of continuous electric arc furnace steelmaking, maintain electricity as the energy base for melting. Other processes, such as coal injection, replace part of the electrical energy; whereas the KS process and the energy optimizing furnace (EOF) would replace all the electrical energy for melting with coal or other fuels. The status of each of these processes is reviewed at the conclusion of this section.

Research Opportunity

There are two possibilities:

1. To develop technologies that would significantly decrease the costs of electric arc furnace steelmaking; and

2. To develop an alternate scrap-based melting process to the electric arc furnace that would reduce production and/or capital costs relative to current technologies.

Current Status

A significant opportunity to decrease the costs of electric arc furnace steelmaking lies with the CONSTEEL process (see Exhibit 1), which employs scrap preheating with furnace off-gasses and auxiliary fuel, continuous melting and slag-free bottom tapping. The process was originally installed by Nucor at the end of 1986 by modifying an existing electric furnace shop. Although Nucor is not currently operating this CONSTEEL facility, a new facility is being built by Florida Steel on a greenfield site.

Both DC arc furnaces and plasma furnaces are in operation. DC furnaces are located at Nucor (28 metric tons), at Florida Steel (36 metric tons) and in France (75 metric tons). These furnaces have the potential for reducing costs, but their relatively low power capability and high refractory and bottom electrode costs are difficulties not yet overcome. Recently, Tokyo Steel announced its intention to install a DC furnace (130 metric tons) in Japan, using a bottom steel electrode. Plasma furnaces (see Exhibit 2), the largest of which is in Austria (45 tons), have also been in operation for several years. These furnaces are experiencing similar difficulties to those encountered with DC arcs.

Replacement of part of the electrical melting energy in the electric arc furnace with coal is the objective of the Klockner-CRA process (see Exhibit 3). Tests are being conducted in Japan at Tokyo Steel. At present, no results are available.

There are several processes in which all the energy for melting is derived from coal or other fossil fuels.[3] Both the KS process and the KMS process are modifications to the bottom blown basic oxygen converter. The KS process (see Exhibit 4) utilizes a 100 percent scrap charge; a 125 ton converter has been in operation in West Germany, using fine coke and natural gas as the energy source for melting. The KMS (Klockner-Maxhutte Steelmaking) process was introduced in 1978 with the objective of increasing the flexibility of the basic oxygen process. The aim was to melt a charge in which up to 75 percent of iron units is derived from scrap, with the balance from hot metal. Based on the experience since 1978 with three 60 ton furnaces at Klockner-Werke AG, West Germany, the KMS process is considered to be proven technology.

The energy optimizing furnace is a coal-based scrap melting process (see Exhibit 5). A 30 ton capacity furnace has been in operation at Companhia Siderurgica Pains in Brazil since 1982 and a 100 percent scrap charge has been melted on an experimental basis. In March of 1988, Companhia Siderurgica Pains commissioned its second 200,000 ton per year (TPY) plant. Rhode Island Forging Steel, Inc. has announced construction of a 300,000 TPY unit to melt a 100 percent scrap charge. Tata Steel (India) has placed an order for a similar size facility. A new 400,000 TPY plant was recently completed by Companhia Siderurgica Aliperti of Brazil. Based on the experience at Companhia Siderurgica Pains, the EOF is considered proven technology.

Conclusion

Based on the foregoing discussion, the scrap-based steelmaking process area is viewed as offering limited opportunity to increase energy efficiency and enhance competitiveness over the current state-of-the-art.

In the area of reducing costs for electric arc furnace steelmaking, many improvements have been proven commercially, but not implemented on domestic furnaces. In general, these improvements and new processes such as CONSTEEL are in a late stage of technological development, and further development on these processes should be undertaken by industry.

A similar conclusion can be reached for alternate scrap-based melting processes. For example, the KS process, EOF, plasma and DC arc furnace are in commercial operation or in a late stage of technological development. These processes use different energy sources and offer a variety of choices for a greenfield scrap-based steel plant.

Notes

(1) R.J. Fruehan, "Alternate Scrap Melting Technologies, Part I," *Iron and Steelmaker*, March, 1987.
(2) CMP Report, *Techno-Economic Assessment of Electrical Steelmaking Through the Year 2000*, July, 1987.
(3) R.J. Fruehan, "Alternate Scrap Melting Technologies, Part II," *Iron and Steelmaker*, April, 1987.

EXHIBIT 1. NEW STEELMAKING PROCESSES -- SCRAP-BASED

Process: CONSTEEL Process

Brief Description:	This is a modification of the electric arc furnace, developed by Intersteel Technology, Inc. The scrap is preheated on an oscillating conveyor, in a preheating tunnel, utilizing furnace off-gases and auxiliary fuel. The preheated scrap is charged continuously and the furnace is tapped intermittently.
Raw Materials:	Scrap
Potential Impacts:	
Energy Sources:	Electricity; optional use of natural gas.
Scrap:	100 percent of the charge is scrap.
Capital Cost:	No data available.
Variable Cost:	Significant cost reduction, in excess of 20 percent, is expected from the use of off-gas for preheating and higher production rate.
Retrofit:	Yes
Technology Status:	
Current:	Nucor in Darlington, S.C., has ceased operations on their CONSTEEL installation.
Future Plan:	Florida Steel is planning to build a new facility on a greenfield site.
Hurdles:	No major technological hurdles.
Scale-Up Potential:	Not applicable - process is commercial.
Expected Timing:	Not applicable.

EXHIBIT 2. NEW STEELMAKING PROCESSES -- SCRAP-BASED

Process: Plasma Furnace

Brief Description:	This is an electric arc furnace modification developed by Voest Alpine and Krupp. The extremely high temperature developed in the (electric) plasma increases the heat transfer for melting of scrap.
Raw Materials:	Scrap
Potential Impacts:	
Energy Sources:	Electricity
Scrap:	100 percent scrap is charged.
Capital Cost:	No data available.
Variable Cost:	Objective is to reduce overall costs. However, to date, the energy costs are higher than in conventional electric arc furnaces.
Retrofit:	Yes
Technology Status:	
Current:	45 ton capacity furnace operating in Austria since 1983.
Future Plan:	Reduce energy consumption, which is reported to be about 10 percent more than the conventional electric arc furnace.
Hurdles:	Plasma torch capacity (6 MW) limits the size of the furnace. Plasma torch life is short (12 hours).
Scale-Up Potential:	Depends on torch capacity development.
Expected Timing:	Depends on the ability to decrease production costs.

EXHIBIT 3. NEW STEELMAKING PROCESSES -- SCRAP-BASED

Process: Klockner-CRA Coal Injected Electric Arc Furnace

Brief Description:	This is an electric arc furnace modification developed by Klockner CRA Technologies. Coal and oxygen are injected into an electric arc furnace.
Raw Materials:	Scrap, coal and oxygen.
Potential Impacts:	
Energy Sources:	Electricity and coal.
Scrap:	100 percent of the charge is scrap.
Capital Cost:	No data available.
Variable Cost:	No data available - potential to reduce costs by replacing electricity with coal.
Retrofit:	Yes
Technology Status:	
Current:	Tests being performed in an electric arc furnace at Tokyo Steel, Japan. No information has been revealed.
Future Plan:	No data available.
Hurdles:	None known.
Scale-Up Potential:	Awaiting results from Tokyo Steel.
Expected Timing:	Estimated to be less than 5 years.

EXHIBIT 4. NEW STEELMAKING PROCESSES -- SCRAP-BASED

Process: KS Process

Brief Description:	This is a modification of the bottom blown converter developed by Klockner CRA technologies. After scrap is charged, natural gas and oxygen are injected to preheat and then melt the scrap to form a molten pool of metal. Fine coke is then injected through the bottom tuyeres, along with oxygen, to complete the melting. Refining of the melt is performed by normal bottom blowing with oxygen.
Raw Materials:	Scrap, fine coke, natural gas and oxygen.
Potential Impacts:	
Energy Sources:	Fine coke and natural gas.
Scrap:	100 percent of the charge is scrap.
Capital Cost:	No data available.
Variable Cost:	No data available - reduction is expected due to the use of lower cost energy source compared to electric arc furnace.
Retrofit:	Yes
Technology Status:	
Current:	125 ton capacity converter operating in West Germany. A liquid heel can be left in the furnace and use of natural gas eliminated.
Future Plan:	Not known.
Hurdles:	Development of post-combustion technology to burn carbon-monoxide to increase heat transfer.
Scale-Up Potential:	Will depend on development of post-combustion technology.
Expected Timing:	Estimated to be less than 5 years.

EXHIBIT 5. NEW STEELMAKING PROCESSES – SCRAP-BASED

Process: Energy Optimizing Furnace (EOF)

Brief Description:	This is a coal based scrap melting process developed by Korf Engineering. Scrap is first preheated by the combusted off-gases from the melting unit and then melted by injection of coal and oxygen. After the batch has been melted, the charge is decarburized/refined with oxygen blown from the bottom tuyeres.
Raw Materials:	Scrap, coal and oxygen.
Potential Impacts:	
Energy Sources:	Coal
Scrap:	Up to 100 percent scrap can be melted.
Capital Cost:	Lower capital cost compared to electric arc furnace.
Variable Cost:	Potential savings of $19 (about 13 percent) per metric ton compared to electric arc furnace.[1]
Retrofit:	No
Technology Status:	
Current:	Two, 200,000 TPY plants are in operation in Brazil. 100 percent scrap charge has been melted.
Future Plan:	300,000 tons/year plant is planned for Rhode Island Steel and for Tata Steel in India. A 400,000 tons/year plant with a 60 ton capacity EOF was recently commissioned by Companhia Siderurgica Alperti of Brazil.
Hurdles:	None known.
Scale-Up Potential:	Process is commercial.
Expected Timing:	Not applicable.

D. SCRAP BENEFICIATION

Background

Although the scrap beneficiation area is part of the raw materials benificiation, it will be treated as a separate process area in this Research Plan. In addition to scrap beneficiation, the raw materials process area contains the agglomeration processes, pelletizing and sintering, that convert iron ore into suitable feedstocks for the blast furnace. These latter areas have been included in the ore- based steelmaking process area that was analyzed earlier in this Plan (see Section IV.B.) and are possible process steps that could be eliminated by the development of a new steelmaking process that uses fine ore as a starting material.

Every year for the past three decades, the availability of iron and steel scrap in the United States has increased; current estimates place scrap availability at about 750 million tons. Although it is difficult to predict steel production statistics for future years, Fruehan states that there will be an increase in the amount of scrap used in the steel industry, primarily due to the increased use of electric furnaces and secondarily due to the increased production from continuous casters.[1] For plants using oxygen furnaces, increased use of casters may increase the amount of purchased scrap, since in-plant generated scrap will decrease as yield improves; for electric furnace shops, increased production from casters will not affect scrap purchases.

In terms of absolute quantity, there is sufficient scrap in the U.S. to permit an increase in scrap usage with attendant reductions in production costs and capital intensity. In addition, the total energy to produce finished steel from scrap is less than one half that required to produce finished steel from the coke oven/blast furnace/BOF route.[2] There remains, however, the question of scrap quality and, in particular, the level of residual elements.

The predominant residual element, and probably the most important, is copper, which can in some grades of scrap reach a level of 0.35 percent. Other important residual elements include tin, chromium, molybdenum and nickel. With the exception of chromium, none of these elements is removed during the steelmaking process.

Unfortunately, residual elements can have an adverse effect on hot ductility and on the properties of steel products, particularly formability. For these reasons, specifications exist limiting the levels of residual elements in various steel products, as shown below:

Table 1. Maximum Residual Element Levels, Percent[3]

Steel Product	Cu	Ni	Cr	Mo	Sn
Deep Drawing Sheets	0.06	0.10	0.07	0.02	0.01
Commercial Quality Sheets	0.10	0.10	0.07	0.03	0.015
Tinplate Critical	0.06	0.04	0.04	0.02	0.02
Low Carbon Wire	0.12	0.08	0.07	0.02	0.01
Cable & Spring	0.20	0.10	0.10	0.03	0.02
Special Quality Bar	0.25	0.12	0.12	0.03	0.03
Merchant Bar	0.35	0.15	0.15	0.04	0.03

As demand for higher quality steels continues to increase, the demand for low residual scrap will also continue to increase, particularly among electric furnace steelmakers seeking to upgrade their product mix.

In the absence of a technically and economically viable method for removing copper (and other residual elements) from scrap, the only alternative to purchasing low residual scrap is to increase the proportion of virgin iron units (e.g., direct reduced iron, hot metal) in the furnace charge. For electric furnace steelmakers, this may represent a substantial increase in liquid steel costs.

Unlike potential technologies in many other process areas that would eliminate one or more process areas, the potential technology for beneficiation of scrap will add a process step. The cost of this additional process step must be evaluated against alternate methods for achieving a similar level of residual elements. On the basis that low residual scrap will continue to be available, but not necessarily in the quantities demanded by the marketplace, steel made from low residual scrap could set a competitive upper limit to steel costs; under this scenario, the relative difference in price between high residual and low residual scrap will determine the *maximum* incremental process costs for beneficiation of high residual scrap, probably about $30/t of liquid steel.[3] If low residual scrap is not available, the cost of any proposed process will have to be at least competitive with the cost of producing low residual steel from the combined use of high residual scrap and virgin iron units. The major benefit from the development of an economically viable process for residual element removal from steel scrap will be increased usage of a low cost raw material in domestic steelmaking operations.

Research Opportunity

Develop a process that will economically remove copper (and other residual elements) from scrap either before, during or after melting.

Current Status

There are several possible methods for removal of residual elements from scrap: (1) vacuum treatment, (2) hydrometallurgical techniques, (3) pyrometallurgical treatments with reactants, (4) physical separation, and (5) bioprocessing. Although none of these methods are *at present* considered economically viable on the scale of most steelmaking operations, some methods, such as physical separation and pyrometallurgical treatments, hold sufficient promise for further research and development.

Although no projects have been funded in this area under the Steel Initiative Program, some preliminary work, funded by DOE's Office of Industrial Programs is underway at Carnegie-Mellon University. This work aims, on a laboratory basis, to assess the viability of removing elemental copper from scrap, using a sulfide matte, at temperatures below the melting point of steel.

Conclusion

Scrap beneficiation, and in particular the removal of residual elements, is an area of opportunity. It is estimated that 750 million tons of scrap are currently available in the United States. Development of an economically viable process for residual element removal from steel scrap would result in an increased use of a low cost, domestic raw material in steelmaking operations.

Notes

(1) R.J. Fruehan, "Scrap in Iron and Steelmaking," *Iron and Steelmaker*, May, 1985.
(2) R.J. Fruehan, "Alternate Scrap Melting Technologies, Part I," *Iron and Steelmaker*, March, 1987.
(3) Data from Center for Metals Production report entitled, *Techno-Economic Assessment of Electric Steelmaking Through The Year 2000*, July, 1987.

E. NEAR-NET-SHAPE CASTING

Background

The near-net-shape casting process area is a new area that replaces several processing areas within the conventional steel flow sheet. The replaced areas include ingot and continuous casting of liquid steel, ingot heating and primary rolling to semi-finished steel, and reheating and secondary hot-rolling of semi-finished steel (either rolled or cast) to hot-rolled products, and possibly, the replacement of part of the finishing operations, such as a portion of cold-rolling of sheet. The value added in this area is large and has been estimated to be $2-4 billion per year for near-net-shape casting of flat-rolled products. The actual value varies depending on the percent of steel being continously cast and on the extent to which reheating and secondary hot-rolling can be eliminated.

In a recent paper entitled "Flat Products Manufacture in 21st Century," Birat stated the following: "*the center of innovative technologies today lies without any doubt in the field of continuous casting. The potential for radical transformation of the flat product steel plant contained in these technologies is tremendous, as well as the ability to stimulate innovation in adjacent fields.*"[1]

There is probably near consensus within the steel industry that the successful development of a process or processes to cast large-aspect-ratio shapes such as strip and thin slabs will have a significant beneficial impact on both production and capital costs. The reasons are obvious when technology for producing hot- and cold-rolled strip is compared with that of potential new casting technologies. In the current process, approximately 10-inch thick cast slabs are charged either hot or cold into the hot-strip mill reheat furnace. After heating to rolling temperature, the slabs are reduced in the hot-strip mill roughing stands to a thickness of about 1 inch and then further reduced to about 0.1 inch in the finishing stands. The steel can be shipped as a hot-rolled band, or further processed on downstream facilities to either hot- or cold-rolled sheet.

In terms of the benefits that are potentially available, the new casting processes for large-aspect-ratio shapes fall into four categories:[2]

1. A thin slab caster capable of producing 20 - 60 mm (0.8 - 2.4 in.) thick slabs that could be fed directly into the finishing stands of a hot-strip mill. The roughing stands of the hot-strip mill would be eliminated; some heating may be required.
2. A thick sheet caster that would cast approximately 5 - 15 mm (0.2 - 0.6 in.) thick strip and require some hot-rolling. The finishing stands of the hot-strip mill could be replaced with a compact hot-reduction mill; some heating may be required.

3. A sheet caster, which would produce product under 5 mm (0.2 in) that could go directly to the cold-rolling mill. All reheating and hot-rolling would be eliminated.

4. A thin sheet caster, which would produce a final product in thickness of less than a millimeter (0.04 in). All reheating and hot- and cold-rolling would be eliminated.

It is difficult to estimate accurately the benefits that would be obtained from the new casting processes, because factors such as capital cost, maintenance and operating costs, energy savings and yield cannot be accurately assessed at this time. It is clear, however, that potential benefits will increase as the number of processing steps eliminated increases, and that potential cost savings on a per ton basis will be significant. The value of the benefits to the steel industry will also be significant; for example, technologies for net-shape casting of large-aspect-ratio shapes are applicable to sheet and tin products that constitute over 50 percent of the steel market. Energy savings in this area could be as much as 0.2 quadrillion BTU per year.

Research Opportunity

To develop near-net-shape casting processes that significantly improve energy efficiency, and reduce production and/or capital costs, as compared with current continuous casting technology. Although casting of large-aspect-ratio shapes offers the greatest value to industry, development of near-net-shape casting processes for structurals, tubes, etc. must also be considered.

Current Status

Significant research and development activities on the development of new near-net-shape casting processes are being conducted in the U.S., Japan and many European countries. Although most of the work is aimed at development of processes for the production of large-aspect-ratio shapes starting with liquid steel, work on near-net-shape casting for other products is also underway using liquid steel, slurries or powder as the casting material.

The most advanced of the technologies for casting large-aspect-ratio shapes is the caster developed by SMS Schloemann-Siemag and designed to cast 40 - 60 mm (1.6 - 2.4 in.) thick slabs, although other companies such as Sumitomo (twin-belt), Danieli and Mannesmann-Demag are offering casters that produce slabs in a similar thickness range. A commercial SMS caster installation has been announced by Nucor for the production of 800,000 TPY of hot- and cold-rolled products at Crawfordsville, Indiana. SMS technology uses a conventional immersed tube pouring system and a unique mold design. The mold is funnel-shaped and expanded in the top area to accommodate the submerged pouring tube. The 2-inch thick slab will be passed through an equalizing furnace and rolled on a 4-stand finishing mill, which has provisions for a fifth stand. Both slab reheating furnaces and the roughing mill are no longer required, although long tunnel furnaces are required to avoid cooling of the thin slabs prior to hot-rolling. Start-up of the Nucor facility is scheduled for 1989.

The status of research and development work on near-net-shape casting processes for large-aspect-ratio shapes has been summarized recently by Birat, and earlier by the IISI Committee on Technology.[1,2] The processes under development can be categorized according to thickness of cast product produced, although some overlap exists. In general, belt casters, SMS and the British Steel Open Mold caster produce the thickest products (10 - 60 mm or 0.4 - 2.4 in.), twin wheel casters produce intermediate thicknesses (1 - 20 mm or 0.04 - 0.8 in.) and single wheel casters produce the thinnest (1 - 2 mm or 0.04 - 0.08 in.). Spray casters should be able to produce a range of thicknesses including ultra-thin sheets.

To maintain current hourly production rates when casting thinner slabs or strip, commensurate increases in casting speed are required. For example, the casting rate of 5 - 6 meters/min. or 197 - 236 in./min. featured by the SMS technology insures a throughput consistent with conventional slab casters. However, the development of casters to produce thinner sections requires the development of new technologies without relative motion between the cast section and the mold. This precludes oscillating mold systems (as in SMS) and leads to the requirement for systems where the solid substrate and solidifying melt travel at the same speed. Belt casters, double wheel (or roll) casters, single wheel (or roll) casters and the British Steel Open Mold caster all use this principle; an exception is electromagnetic casting where moving substrates are not required.

Mold design is just one of the difficult problems facing research and development workers in the U.S., Japan and Europe. To produce large-aspect-ratio shapes with thicknesses less than 0.6 in. requires the development of new pouring systems. Also required is the development of systems to strip the steel from the mold without damage and the development of cast product handling systems. Stringent surface quality requirements, and the fact that some hot-rolling may be necessary to develop the required properties in cold-rolled sheets, are added hurdles to process development.

With the exception of the SMS process which is being commercialized by Nucor, the successful strip casting of stainless steels by Allegheny Ludlum, and the announcement by Mannesmann Demag of the construction of a strip caster in Brazil for the production of strip for electric resistance welded pipe, the near-net-shape casting processes for production of large-aspect-ratio shapes are in the developmental stage. The research and development work is, in the main, being conducted on small pilot- or bench-scale casters; cast widths are narrow. Many years of development work are envisioned before strip casters capable of meeting the width, surface and other quality requirements of many steel products can be designed and installed in steel plants.

Aside from the three technologies described previously, it would be extremely difficult, at this time, to predict which of the near-net-shape casting processes for large-aspect-ratio shapes will become candidates for commercialization. Within a given cast thickness objective, there are several competing technologies; for example, 0.4 in.-thick sheets could potentially be produced by twin-wheel casting[1], belt casting[1], or spray casting. In addition to the competing technologies for a given thickness objective, product requirements add another dimension. For example, single wheel processes are candidates for producing sheet steels that can be processed directly on a cold mill; however, there is evidence that some cold-rolled steels may require hot working to develop the required properties, such as preferred orientation, which may negate a single wheel process approach.

Conclusion

With the exception of thin slab casting, which Nucor is installing at its new plant at Crawfordsville, Indiana, near-net-shape casting -- in particular near-net-shape casting of large-aspect-ratio shapes -- is a high opportunity area. It is expected that one strip casting process will eventually dominate for the production of carbon sheet steels, with other strip casting processes being used for niche production of special steels. Because it is not possible to predict which process or processes will become candidates for commercialization, funding of several near-net-shape casting proposals may be justifiable, depending on their benefits relative to other research opportunities.

Notes

(1) J. P. Birat, "Manufacture of Flat Products for 21st Century," *Ironmaking and Steelmaking*, Vol. 14, No. 2, p. 84, 1987.

(2) "Continuous Casting of Steel 1985; A Second Study," *International Iron and Steel Institute*, 1986.

F. THERMOMECHANICAL PROCESSING

Introduction

The thermomechanical processing area is not a large area in terms of the value added by the steel industry. This area does offer some unique research and development opportunities. New and improved products could be developed and there is some opportunity for decreasing costs, increasing energy efficiency and enhancing competitiveness. Two possibilities will be discussed: (1) thermomechanical processing of plate steels and (2) development of ultra-high carbon superplastic steels.

In the United States today, the principal method of increasing the strength and toughness of steel plate is by heat treatment. This process is an energy intensive batch process that follows the completion of secondary hot-rolling. Several different types of heat treatments are used depending on steel grade and the intended end use. In the context of thermomechanical processing, two types of heat treatment are important:

1. Normalizing, which consists of heating the steel above its critical temperature range (typically around 1600°F depending on steel composition) followed by air cooling. The purpose is to refine the coarse grain size of the conventionally as-rolled product and to establish a uniform, relatively fine grained microstructure that exhibits good toughness characteristics.

2. Quench-and-Tempering (Q&T), which consists of heating the steel to a suitable austenitizing temperature, holding at that temperature to effect the desired crystalline structure and then immersing the steel in a suitable liquid medium; following this quenching operation, the steel is tempered by heating to around 1000°F (actual temperature depends on steel grade and desired mechanical properties) and cooled to ambient temperature. Quench-and-tempered steels exhibit excellent toughness characteristics.

Today, normalizing and quench-and-tempering treatments are being replaced by thermomechanical processing.[1] This is a hot-rolling, time-temperature deformation treatment, also referred to as controlled rolling, that results in a continuous process for producing steel plates that have properties in the as-rolled condition that equal or exceed those of heat treated plates.[1] In addition to the energy, manpower and capital savings from the elimination of the normalizing treatment and reheat portion of the Q&T treatment, the thermomechanical processing has the added advantage of reducing alloy content (decreased costs) and concomitant improvements in weldability. Plates are thus cheaper to make and cheaper to fabricate.

The concept of thermomechanical processing of plate steels is to condition the austenite to transform on cooling to a fine grain ferrite structure. Ferrite grain size is unique since it is the only microstructural parameter that simultaneously increases both strength and toughness.

The initial controlled rolling practices developed in the 1960's conditioned the austenite through a succession of rolling passes at progressively lower temperatures. Since much of the deformation is carried out at relatively low temperatures (below the austenite recrystallization temperature of about 1550°F), mill loads are high. In addition, mill productivity is low because of the lengthy hold times required to allow the slab to cool after the roughing passes and prior to commencement of the finishing passes. For these reasons, the initial application of conventional controlled rolling process was almost exclusively for the production of plates for line pipe. These plates are relatively thin (less than 20mm) and uniform in size; also, order lots were usually large as compared with other plate products.

Controlled rolling technology has advanced over the past 15 years. More powerful rolling mills have been built, the rolling process was computerized and a better understanding of the process was obtained. Control rolled steels (as-rolled) started to replace some heat treated steels, particularly in the lower strength and thickness ranges.

Accelerated cooling after control rolling is a relatively new thermomechanical process for the production of steels with improved combinations of strength, toughness and weldability. After rolling, the plate enters a water spray facility. The faster cooling rate, as compared with air cooled controlled rolled plates, results in a finer ferrite grain size and improved plate properties. Consequently, the controlled rolled steels that have been subjected to accelerated cooling extend the strength/thickness range in which as-rolled steels replace heat treated steels. Several accelerated cooling facilities are in operation abroad, particularly in Japan, and the technology is considered to be proven.[1]

The latest development in thermomechanical processing is direct quenching.[1] After the steel is control rolled, the steel plate is quenched directly using on-line quenching equipment. As indicated above, in conventional plate processing, the plate is air cooled off the mill to ambient temperature, reheated and then quenched using off-line equipment. In both processes a tempering treatment has to be used. The implementation of direct quenching further extends the range in which hot-rolled steels can replace heat treated steels.

Because direct quenching is a new process, few installations are operating. Sumitomo is the leading producer, having produced over 50,000 tons.[1] Also, the development of the process has, in a sense, preceded the alloy research and development work; consequently, there is an opportunity to tailor new, lower cost steel chemistries to the direct quench process to effect improved strength/toughness relationships and weldability.

There is a second thermomechanical processing approach that offers possibilities for producing steels with superior mechanical properties. These are the superplastic, ultrahigh carbon steels that were developed at Stanford University and have potential applications for rails, gears and wear resistant components.[3] Superplasticity refers to the ability of a material to develop unusually high tensile elongations, often well in excess of 1000 percent, at temperatures between 0.4 and 0.6 of their absolute melting points. The unusual behavior is associated with the presence of an ultrafine-grain stable microstructure. The new steels have a high carbon content, over 1 percent, whereas most commercial steels have carbon contents less than 1 percent. The steels have exceptional strength and ductility and exhibit superplasticity at intermediate temperatures (about 1200°F) which permits reduction in fabricating costs.

Research Opportunities

To develop new, less expensive plate steel compositions with improved mechanical properties and weldability, that are tailored to state-of-the-art thermomechanical processes, such as direct quenching off the mill.

To develop processes for the manufacture of steels having ultrafine microstructures suitable for superplastic forming into steel products.

Current Status

The U.S. Department of Defense, through its Title III program, is providing incentives to private industry to create a capacity for the production of accelerated cooled and direct quenched steel plate for Naval vessels and armored vehicles construction. Phase I of the program calls for three domestic steel suppliers to melt steels in the U.S. that will qualify for different strength grades. The steel slabs will be processed to plate on state-of the-art facilities in Japan (or elsewhere), and then evaluated in the U.S. to determine costs, weldability and mechanical properties. Based on the results of Phase I, a leading domestic steel supplier will be selected in Phase II, and a second supplier in Phase III.

On March 23, 1988, a meeting was held at the Colorado School of Mines (CSM) attended by representatives of the major domestic steel plate producers, high performance plate users, CSM, Federal Laboratories and DOE. The purpose of the meeting was to determine if an opportunity for a research and development program in the area of thermomechanical processing could be defined. It was determined that because the direct quench process for plate steels is proven technology in both Japan and Europe, the only opportunity for a research and development program is development of alloys uniquely tailored to the direct quench process thereby improving strength-toughness relationships, weldability and fabricability. After extensive discussion of this opportunity, it was concluded that it was not possible, at the present time, to formulate a program that would apply to a significant steel tonnage and therefore have a significant potential benefit to the steel industry.

In March of 1988, a cooperative research and development program between Lawrence Livermore National Laboratory; Caterpillar Tractor, Co.; North Star Steel Co. and Ladish Co., Inc., with involvement of Stanford University, was undertaken with funding from DOE's Steel Initiative. The objective of the program is to develop the processing conditions, on a commercial scale, that will result in superplastic behavior in ultra-high carbon steels and then to demonstrate the technical and economic viability of using these steels in the production of forged steel products. Phase I of this work is expected to be completed in September 1989.

Conclusion

A project to develop processes for the manufacture of steels suitable for superplastic forming is underway at Lawrence Livermore National Laboratory. It has not been possible to define a program in the general area of thermomechanical processing of plate steel. No further opportunities for research and development in this area have been identified.

Notes

(1) Harry I. McHenry, "Thermal Mechanical Processing of Steel Plates," *Scientific Bulletin*, Vol. 9, No. 3, 1987.

(2) O. D. Sherby and J. Wadsworth, "Overview; Superplasticity and Superplasticity Forming Processes," *Journal of Materials Science and Technology*, Vol. 1, 1985, p. 925.

G. THE DEVELOPMENT OF UNIVERSAL GRADES OF STEEL

Background

The development of universal grades of steel was proposed as a possible area of research early in the Steel Initiative program. This is an ambitious idea that, if successful, would result in a reduction in the number of grades of steel, improvements in liquid steel to finished product yield and reductions in steel processing costs. However, this idea, as discussed below, may have been superceded by recent developments in the steel industry.

The concept of reducing the number of steel grades requires that steel product properties be developed primarily by subjecting "generic" steel compositions to different thermomechanical processing cycles. Thermomechanical processing thus becomes the key variable controlling steel product properties rather than steel chemistry, as in current practice.

The production of fewer grades of steel and steel chemistries would reduce steelmaking costs; liquid-to-solid steel yield during the continuous casting process should be improved through a reduction in the incidence of the intermix region in cast slabs, blooms or billets due to less down-grading and rejections of cast product due to "off" chemistry. (The intermix region is the region in the cast product where the composition is intermediate between that of the heat currently being cast and that of the heat cast previously.)

Since the initial idea of development of universal grades of steel as a Steel Initiative project was proposed, steel processing technology has changed. Many steel companies have invested in sophisticated ladle metallurgy facilities to improve quality, increase production rates and reduce costs. It is now common practice to produce a generic steel in the basic oxygen furnace or electric arc furnace and then to do the final refining steps, and chemistry and temperature adjustments, in the ladle metallurgy facility.

As stated previously, any reduction in the number of grades of steel requires that thermomechanical processing cycles be developed so that a variety of product properties can be produced from a single steel grade or composition. The development of near-net-shape casting processes will make this goal more difficult to achieve. Casting steel products closer to their final product dimensions decreases the amount of rolling and therefore the amount of thermomechanical processing needed to achieve final dimensions. Since less rolling is required, the opportunity to achieve significantly different product properties from a single steel grade is decreased.

Research Opportunity

To reduce the number of grades of steel and to move toward the development of universal grades of steel.

Current Status

No proposals have been submitted to DOE in this area. DOE is unaware of any research and development program that aims to reduce the number of grades of steel for a broad range of steel products.

Conclusion

Although there is an opportunity to reduce the number of grades of steel and to move toward the development of universal grades of steel, the development of sophisticated ladle metallurgy equipment and practices has reduced potential benefits. In addition, the development and commercialization of near-net-shape casting processes will make it more difficult to achieve a variety of product properties from a single steel composition. Consequently, this is considered a low opportunity area.

H. AUTOMATED PROCESSING TECHNOLOGY

Background

Early in the Steel Initiative Program, the development and application of automated processing technology was proposed as one of the possible areas for research. The area of automated processing technology and computer technology affects all process areas within the steel flow sheet. Computers are already being used in the steel industry for process control and to perform many business functions, with demonstrated savings in materials, labor and energy. However, the use of computer technology has the potential to effect further cost savings and quality improvements through the effective utilization of information. Specifically, the application of artificial intelligence, and the development of expert systems for process and inventory control, production scheduling, and customer service, are necessary investments that the domestic steel industry must make if it is to improve energy efficiency and enhance competitiveness. Development of new sensors should be considered to be an integral part of the development of automated processing technology.

Potential benefits in this area are difficult to assess. Since almost all process areas within the steel process flow sheet could be improved by the application of artificial intelligence and the development of expert systems, benefits could be substantial. In a sense every dollar of value added in the steel process flow sheet is a potential target for reduction by automated processing technology.

Research Opportunity

To develop automated processing technology, including application of computer technology, artificial intelligence and the development of expert systems, to all aspects of the steel process flow sheet, to production scheduling, business planning and customer service.

Current Status

The importance of this area to the steel industry has been recognized by the American Iron and Steel Institute (AISI). Research, sponsored by AISI, is underway at the Northwestern University Steel Resource Center on strategic planning of manufacturing operations and on an expert system for slab disposition from a continuous caster.

In a paper entitled "Future Trends in the Technological Evolution of the Japanese Steel Industry," published in the December 1988 issue of *Iron & Steelmaker*, an idea of how steelmaking processes are expected to change by the year 2000 was presented. The flow sheet of the future includes smelting reduction, a converter, near-net-shape casting, cold-rolling and heat treatment; the whole flow sheet is linked together by an artificial intelligence system. This and other information on continuous on-line processing and automation, strongly suggests that the importance of this area has also been recognized by the Japanese.

Conclusion

Automated processing technology including the application of computer technology and artificial intelligence and the development of expert systems, is an area of opportunity for funding under the Act. Development of new sensors may be required. Benefits from automated processing technology could be substantial.

I. FINISHING

Background

The complexity of the steel process flow sheet increases as iron units move from the hot metal and steel producing facilities, through casting and hot-rolling to the finishing operations. At the front end of the process two steelmaking processes dominate, the basic oxygen furnace and the electric arc furnace. In 1987, 52 million tons of steel were made by the basic oxygen process and 34 million tons were made by electric arc furnaces. Thus, at the front end of the steel process flow sheet, the tons flowing through a specific process step, such as iron-making, hot-metal based steelmaking or scrap-based steelmaking, are large and the total value added can be considerable.

Conversely, toward the finishing end of the steel manufacturing process, the steel process flow sheet diverges as many different processing routes, each with unique processing steps, are required to produce a variety of hot- and cold-rolled sheets, zinc and tin coated sheets, plate, tubular, structural, bar, rod and wire products. In consequence, the number of tons of steel that is produced by a single finishing operation is less than the number of tons produced by production facilities at the front end of the process. For example, in 1987 about 3 million tons of steel sheets were coated with tin, 1 million tons coated with chromium, 8 million tons coated with zinc by the hot-dip process and over 1 million tons plated with zinc by electrolytic processes. Although the total value added in all finishing operations is large, the value added in a specific process step is, in most instances, significantly less than that of process steps at the front-end of the steelmaking flow sheet.

This is not meant to imply that research and development projects proposed in the finishing area lack the potential to fulfil the purposes of the Act. The finishing area may offer many opportunities to increase energy efficiency and enhance competitiveness. For example, yield savings and more efficient heat treatment operations can decrease energy consumption, whereas improvements in product quality, reductions in operating cost and development of new products enhance competitiveness. Identification of specific research and development opportunities that fulfil the purposes of the Act requires an extensive in-depth study of the steel finishing area. Because of the large number of processes involved, some of which are company-specific, DOE feels that attempting to define specific opportunities is not warranted. However, it should be emphasized that the development and application of automated processing technology (see Section IV.H.) to existing processes within the finishing area, including the necessary sensor developments, could result in benefits in yield, energy efficiency, product quality and operating cost.

Research Opportunity

No specific opportunities have been identified.

Current Status

Because of the complexity of the steel process flow sheet for finishing operations, and because of the large number of processes involved in producing the many different steel products required by the steel consumer, no attempt will be made to summarize the technologies that are either currently in use or under development.

Conclusion

Although no specific opportunities have been identified, the steel finishing area may offer opportunities to increase energy efficiency and enhance competitiveness, particularly through the development and application of automated processing technology and sensors.

J. ENVIRONMENTAL

Background

In the Act, the Secretary of Energy was directed to consider a number of research areas for possible inclusion in the updated Research Plan. With the exception of two areas, all the areas mentioned in the Act have been considered in prior sections of this Plan (see Sections IV.B. through IV.I.).

The exceptions are:

(1) The development of technologies and equipment related to the production of steel that enhance the protection of the environment and the safety and health of workers.

(2) The treatment and storage of waste materials and other byproducts from steel production and processing.

Both of these areas can be classified under the general category environmental.

By its very nature, the steel industry has great potential to do damage to the environment. Large quantities of impure raw materials are handled and reacted at temperatures in excess of 3000°F giving rise to a variety of effluents. Potential sources of particulate emissions to the air include sinter plants, coke ovens, blast furnaces, steelmaking furnaces and vacuum degassing operations; in addition, particulate emissions can occur during casting of pig iron and liquid steel and also during handling of solid materials such as ore and coal. The potential sources of water pollution include waste waters from many of the operations mentioned previously; additional potential sources include waters from rolling, pickling and coating operations. Significant quantities of solid waste materials are also generated; for example, slags from blast furnace and steelmaking operations, tailings from ore beneficiation processes and dusts from steelmaking processes.

The technology in place today provides a high degree of environmental protection by capturing emissions to the air, removing pollutants from waste water and either controlling releases from waste materials or treatment of these products into a non-hazardous waste material. However, the cost is great in terms of capital investment and operating costs. It has been estimated by AISI that from 1951 through to 1987, the steel industry invested over $6 billion in environmental control equipment. Costs in 1988 to operate and maintain this equipment are probably in excess of $1 billion.

Research Opportunity

To develop innovative, energy efficient, cost effective solutions to environmental problems, that also reduce the amount of material requiring capture or treatment.

Current Status

The steel industry utilizes a broad range of facilities and operating practices to remove particulate matter and gaseous contaminants from gaseous streams, to remove suspended solids and chemical contaminants from aqueous streams and to treat waste products in an environmentally sound manner. Because of the many different types of facilities and processes employed by the steel industry to solve environmental problems in the air, water and solid waste areas, no attempt will be made to summarize the technologies that are either currently in use or under development.

The most economic approach to the solution of environmental problems in the steel industry is to move from the traditional, open batch-type processes toward the development and installation of closed continuous-type processes. As compared with open batch-type processes, closed continuous processes eliminate process steps and therefore sources of particulate emissions and waste water; less solid waste materials are also generated. For example, the development of a direct steelmaking process that will convert unagglomerated iron ore (or pellets) to steel using coal as a reductant not only aims to reduce capital expenditures and operating costs, but also to be less polluting than the current batch technology (see Section IV.B.). The development of near-net-shape casting processes will have similar environmental benefits through the elimination of reheating and rolling steps.

Conclusion

The development of a direct steelmaking process and near-net-shape casting processes may offer the best approach to solution of environmental problems. Exclusive of these developments, it is difficult to envision projects in the environmental area that have the potential to make a major impact on the steel industry.

K. CONCLUSIONS – STEEL

The objective of the Steel Research Plan is to identify and establish priorities for research and development opportunities that can increase energy efficiency and enhance competitiveness of the American Steel industry. All major process areas, or combination of process areas, where preliminary analysis suggests there is an opportunity to increase energy efficiency and enhance competitiveness have been analysed. In addition, other areas suggested in the Act have been considered.

Of the process areas selected for analysis, ore-based steelmaking and near-net-shape casting are areas where the opportunity to fulfill the purposes of the Act is highest. The value added and potential benefits in these process areas are very large and clearly defined research and development opportunities exist.

Automated processing technology, including the development of sensors, should also be considered a high opportunity area; development work in this area could affect all phases of the steelmaking flow sheet. Although benefits in this area are potentially large, specific research and development opportunities need to be defined.

Thermomechanical processing and scrap beneficiation are areas of opportunity where specific research and development programs have been defined. There is less maximum potential benefit in these areas than in the ore-based steelmaking and near-net-shape casting areas.

The development of a direct steelmaking process and near-net-shape casting processes may offer the best approach to addressing environmental problems.

Although no specific opportunities have been identified in the finishing area, there are opportunities to increase energy efficiency and enhance competitiveness particularly through the development and application of automated processing technology and related sensor developments.

In both the scrap-based steelmaking and the universal grades of steel areas, the opportunity to increase energy efficiency and enhance competitiveness is considered the lowest. In scrap-based steelmaking, several new processes are in the late stage of technological development and some have recently been commercialized. In the universal grades of steel area, recent advances in metallurgy practices and potential developments in near-net-shape casting, have reduced research and development opportunities.

V. ALUMINUM RESEARCH PLAN

A. INTRODUCTION

The methodology applied to the development of the Aluminum Research Plan is similar to that used for the Steel Research Plan. As in the case of steel, the aluminum process flow sheet is complicated and division of the flow sheet into process areas is to some extent subjective. In formulating the Aluminum Research Plan, all the process areas where preliminary analysis suggests there is an opportunity to increase energy efficiency and enhance competitiveness have been analyzed. In addition, other areas suggested in the Act have been considered. Where possible, an estimate of the value added in a process area has been made; also, an estimate has been made of the potential benefits that can be obtained by research and development efforts.

Based on the above considerations, the following process areas have been analyzed:

- Alumina Production
- Production of Aluminum from Alumina
- Recycling, Remelt and Refining Technologies
- Near-Net-Shape Casting
- Manufacture of Mill Products
- Manufacture of Cast Products
- Automated Processing Technology
- Environmental

B. ALUMINA PRODUCTION

Background

Aluminum is the third most abundant element in the earth's crust. It is present predominantly as aluminum oxide, or as a more complex oxide in other minerals. The most important alumina ore is bauxite, which contains 40-60 percent alumina. High quality bauxite deposits are found in Australia, Brazil, Guinea and Jamaica. Alumina is extracted from bauxite by the Bayer process; this process has been the preferred alumina production process for the last 100 years. At present rates of production, known reserves of bauxite are sufficient to ensure production of aluminum from bauxite for at least the next hundred years.

After bauxite has been mined and crushed, it is ground in wet grinding rod mills to form a slurry that is suitable for introduction into the Bayer process. The first step in the Bayer process is digestion, where as much as possible of the alumina and a minimum of the impurities are dissolved in a solution of sodium hydroxide at elevated temperatures. In the next step, clarification, the sodium aluminate solution is separated from the solid materials by a process of filtration and sedimentation. The process residue, known as red mud, is pumped as a slurry to disposal areas. Red mud contains sodium aluminum silicate, formed by the reaction of clays with sodium hydroxide solution, as well as oxides of iron and titanium.

The third step in the Bayer process is the precipitation of aluminum hydroxide from the sodium aluminate solution. To accomplish this, the sodium aluminate solution is cooled and seeded with aluminum hydroxide. In the final step, the precipitated aluminum hydroxide is calcined to remove both the contained free water content and the chemically bound elements of water to yield alumina. The alumina is over 98 percent pure and is suitable for smelting in the Hall-Heroult cell.

Even though the Bayer process has undergone a series of evolutionary developments in the last two decades that have decreased energy consumption and improved productivity, opportunities may still exist for further incremental improvements that would increase energy efficiency and enhance competitiveness.

As indicated previously, all known high grade bauxite deposits exist outside the United States. Consequently, the domestic aluminum industry imports almost 100 percent of its primary aluminum units either as bauxite ore, or as alumina produced by the Bayer process. It is estimated that about half of aluminum units are imported as bauxite and about half as alumina.

The United States contains abundant supplies of alumina-bearing raw materials, such as the kaolin clays in Georgia and South Carolina; however, all research and development efforts in the United States and other industrial countries, where similar ores are found, have failed to define a competitive alternative to the extraction of alumina from bauxite by the Bayer Process.

The value added by the domestic industry in this process area is restricted to that added to bauxite imported into the United States and subsequently converted to 98 percent plus purity alumina. In 1987, over nine million metric tons of bauxite were imported into the United States. The estimated value added in extracting alumina from bauxite by the Bayer process is to be about one billion dollars per year.

Research Opportunities

In general terms, two process options exist:

> Option One -- To develop incremental improvements to the Bayer process that will improve energy efficiency and enhance competitiveness.
>
> Option Two -- To develop a new process for the production of alumina, based on either domestic sources of alumina, or the extraction of alumina from waste streams, such as fly ash, which contains about 30 percent alumina.

Current Status

Option One -- The Bayer process is a mature, energy efficient technology, that has undergone many improvements since its development almost 100 years ago. It is capital intensive and requires over 10 million Btu to produce a ton of alumina. Even though improvements have been made to the Bayer process during the last two decades, opportunities may still exist for further incremental improvements in energy efficiency and operating costs. Such opportunities, if successfully developed, are unlikely to have a major impact on the competitiveness of the aluminum industry, since the maximum potential benefits from research and development efforts are significantly less than those in the primary production of aluminum in the Hall-Heroult cell.

Option Two -- This option, which is to develop a new process for the production of alumina based on domestic sources of alumina ore, or based on the extraction of alumina from waste streams, such as fly ash, must be regarded as a high-risk research and development venture. Previous efforts to develop an alternate process, based on domestic ores, such as hydrochloric acid leaching-liquid ion exchange, nitric acid process-liquid ion exchange and the Toth alumina process have not been cost competitive. However, new approaches to the extraction of alumina from ores or waste materials should be considered.

Conclusions

The alumina production process area is viewed as offering limited opportunity to increase energy efficiency and enhance competitiveness. Incremental improvements to the Bayer process will not have a major beneficial impact on the competitiveness of the domestic aluminum industry and development of a new process is considered to be a very high risk venture.

C. PRODUCTION OF ALUMINUM FROM ALUMINA

Background

The production of aluminum from alumina (primary aluminum) is the most significant process area within the aluminum process flow sheet. In 1987, production of primary aluminum was 3.347 million metric tons. It is estimated that the value added in this area exclusive of the cost of alumina, is about 3 billion dollars per year.

Virtually all primary aluminum is produced in Hall-Heroult cells via the electrolytic reduction of alumina. The process is both capital and energy intensive. It is estimated that fixed costs total about one fourth of the total operating costs with energy, labor and raw materials being the other major cost components. About 70 percent of the energy used in the production of aluminum is consumed during electrolytic reduction; the remaining 30 percent is divided between alumina production and fabrication. Thus research and development in the production of aluminum from alumina has a large potential to increase energy efficiency and enhance competitiveness.

A Hall-Heroult cell consists of a rectangular steel shell lined with carbon. The unit is thermally balanced to permit the formation of a frozen layer of bath on the sidewalls that serves to contain the molten electrolyte at approximately 960°C. The bath consists mostly of cryolite. Alumina is dissolved in the bath and is electrolytically decomposed by direct current. Aluminum is deposited on the cathode, where it accumulates until it is siphoned from the cell. Anode carbon is consumed by reaction with oxygen resulting in the formation of carbon dioxide.

Approximately 0.43 pound of carbon and 6.2 kilowatt hours of electrical energy are consumed in the most modern reduction cell to produce one pound of aluminum. The theoretical energy required to reduce alumina at 960°C is 2.89 Kwh/lb (with carbon in the system) and 4.20 Kwh/lb (without carbon). This means that the most efficient cell today has a 47 percent power efficiency. The average Kwh/lb used in the United States is 7.4, leading to an average cell power efficiency of 39 percent. Electrical energy, even at the favorable rate of 25 mils/Kwh, represents approximately one third of the variable operating costs for domestic primary aluminum producers. The total electrical energy consumed in the United States by the Hall-Heroult cells is estimated to be about 50 billion Kwh.

The U.S. primary aluminum production capacity has been reduced over the last 10 years by 20 percent to 3.9 million tons. In 1987, the United States imported almost 1.9 million tons of ingot and semifabricated aluminum. High costs of electrical power, capital and labor mitigate against construction of new capacity in the U.S. Most of the U.S. primary capacity has been fully depreciated; the newest Hall-Heroult cells in the U.S. are 13 years old. Variable costs of production for old U.S. plants are approximately equal to fully burdened costs at new plants in foreign countries. Because of this, low capital retrofit technologies that aim to reduce energy consumption in Hall-Heroult cells should provide large cost benefits for the domestic aluminum industry. For example, it is estimated that the application of retrofit technology could result in energy savings of between 1-2 Kwh/lb; this equates to energy savings of 200 to 400 million dollars per year if retrofit technologies were successfully applied to all domestic production.

Over the last 100 years, alternate reduction systems to the Hall-Heroult method have been evaluated. The aim of these efforts is to develop a process that is less energy and capital intensive as compared with the Hall-Heroult process. The chloride process (Alcoa Smelting Process) is the most recent chemical system to be tested at demonstration stage. Also, numerous direct reduction carbothermic processes have been evaluated. Further information on the status of these efforts is given in the "Current Status" section below.

Research Opportunities

In general terms, two research and development options exist:

> Option One -- To develop retrofit technologies for the Hall-Heroult process that will increase energy efficiency and enhance competitiveness.
>
> Option Two -- To develop a new aluminum production process that is less energy intensive and less capital intensive than the existing Hall-Heroult process.

Current Status

Option One -- Energy efficiency in the Hall-Heroult reduction cell could be increased by as much as 30 percent through the development of improved anode and cathode materials and through electrolytic cell designs that take advantage of these new materials. Current work sponsored by the Department of Energy seeks to develop a non-consumable anode and a wettable cathode that would permit a significant reduction in the anode/cathode distance in the Hall-Heroult cell, and therefore a reduction in the electrical resistance across the electrolyte. Also, replacement of the conventional carbon-based anodes, which have a high imbedded energy value and are consumed quite rapidly in normal operation of the cell, will reduce energy consumption.

In the Hall-Heroult cell, carbon dioxide is produced at the carbon anode. Replacement of the carbon anode with an inert anode results in the evolution of oxygen rather than carbon dioxide. The decomposition potential to produce oxygen is one volt higher than that to produce carbon dioxide, and therefore represents a potential energy increase; however, 80 percent of this higher decomposition potential of inert anodes is offset by voltage savings in the anode rod connection, anode resistance and lower overvoltages at the anode face. Because the inert anode will be replaced in periods of years rather than weekly, improved control of the cell will result from the elimination of the traveling wave in the metal pool, which is generated during anode change-outs and propagated by magneto-hydrodynamic effects. The use of inert anodes should allow the balancing of electro-magnetic forces, which will allow the reduction of the anode cathode distance, thereby generating less heat and saving energy.

Replacement of consumable carbon anodes with inert anodes has the highest potential for reducing and providing energy savings in present reduction cells. Very promising results have been obtained at Pacific Northwest Laboratories (PNL), in a program funded by DOE using nickel-ferrite-copper cermet anodes. Very low wear rates have been obtained; but the results to date are limited to short-term, small-scale tests. Larger-scale tests in 500 amp cells are planned. PNL is also engaged in an extensive research program to develop improved microstructures for these cermet materials and define the optimum cell operating conditions. In a parallel study funded by DOE, the University of California,
Berkeley is developing mathematical models supported by empirical water model data for the design and evaluation of new cell configurations.

An additional DOE project, cost-shared by ELTECH, is being pursued in this area. ELTECH is developing a cerium oxide coating that forms *in situ* on the cermet anode. This thin ceramic barrier lowers the dissolution rate of the anode, providing longer anode life, less impurities in the aluminum, and a wider range of operating conditions than with an uncoated inert anode. The drawbacks are the increase in ohmic voltage drop and the recycling of some cerium in the form of cerium fluoride. Results to date indicate *in situ* formation is viable. Bench scale testing has been completed and the results are being evaluated to determine if larger-scale, longer-term testing is warranted.

The total benefits of the inert anode, however, cannot be generated until a cost effective, stable cathode material is developed. In this regard, a cost-shared project is in place with Great Lakes Research Corporation (GLRC) and Reynolds Aluminum to develop GLRC's patented titanium diboride-graphite material. This material, which may be used alone or with the inert anode to save energy and reduce cost, has been shown to exhibit a low dissolution rate and acceptable thermal shock resistance in sample tests conducted in commercial cells.

Also, ELTECH and Alcan have formed a joint venture to develop a cathode bottom to reduce the bottom voltage losses with inserts of titanium diboride into an alumina bottom. The savings here are small compared to the savings obtained with a combination of inert anode and stable cathodes, but sufficient to gain the interest of major aluminum producers.

Option Two -- Numerous direct reduction carbothermic processes have also been evaluated over the last 100 years. In carbothermic processes, coke is both the reductant and the fuel source. Reynolds has recently operated a pilot scale unit, but the risk reward ratio was not sufficiently favorable to move this technology to demonstration level. Also, recent investigations by the Massachusetts Institute of Technology, sponsored by the Department of Energy, have led to a new carbothermic reduction concept that is technically viable, but requires major advances in the materials of construction and separation processes to be economically viable.

Many alternates to the Hall-Heroult cell have been investigated over the past decades; these alternates seek to maintain electricity as the energy source and as the driving force for the reduction of alumina to aluminum. The most recent of these to be tested at the demonstration stage is the Chloride Process (Alcoa Smelting Process). This technology replaces the carbon plant with a chemical plant to produce aluminum chloride and replaces the Hall-Heroult cell with a more efficient bipolar cell. This technology has been shelved by Alcoa because the economic benefits did not outweigh the remaining risks.

At the present time there are no emerging technologies that can be considered as economical alternates to the Hall-Heroult process.

Conclusions

The production of aluminum from alumina is a high opportunity area for funding under the Act. Development of retrofit technologies for the Hall-Heroult cell through, for instance, development of non-consumable anodes and wettable cathodes, improved cell design and low temperature bath systems, would increase energy efficiency and enhance competitiveness. The development of a new process for the production of aluminum is considered to be a very high risk venture.

D. RECYCLING, REMELT AND REFINING TECHNOLOGIES

Background

Recycling of aluminum has increased significantly over the last decade. In 1967, 797,000 metric tons of aluminum were recovered from scrap representing 23 percent of the total domestic aluminum production. In 1987, these numbers had increased to 1,847,000 metric tons and 36 percent respectively. As compared with the production of aluminum from ore (primary aluminum), recovery of aluminum from scrap (secondary aluminum) requires only a fraction of the energy, about 5 percent; also, both capital costs and operating costs are lower.[1]

Key problems for the recycle industry are the ability to separate aluminum from other materials and metals, to remove coatings and contaminants and to reduce the magnesium content of the melt.[1] Magnesium is unique among the alloying elements used in the aluminum industry; it is higher in the electromotive series than aluminum and will react preferentially with halogens. Magnesium can thus be removed from molten aluminum by the injection of either chlorine or fluorine gas. When scrap is contaminated with alloying elements other than magnesium, only two options exist: 1) the problem can be minimized by application of the melt to the same product, or to a similar product, as the scrap from which it came, for example, by converting beverage can scrap into can stock; or, 2) diluting the melt with virgin aluminum units.

Recycling technologies are an important facet of the domestic aluminum industry. Aluminum scrap is the only economical domestic source of aluminum. Although there is an abundant supply of aluminum ores in the United States, no technology has been developed for the economic extraction of aluminum from these ores. Consequently, almost all the primary aluminum produced in the United States is imported from foreign sources, either as bauxite or as alumina. In addition to the imports of bauxite and alumina, net imports of aluminum to the United States totaled 2,103,506 metric tons in 1987. Because the United States has the largest consumption of aluminum, over 15 billion pounds in 1987, and the largest per capita consumption, 60 pounds, the opportunity to recycle aluminum is greater in the United States than in any other country in the world. These facts, combined with the low energy consumption and the low cost of recycle technologies as compared with the energy consumption and cost to produce aluminum from bauxite ore, are incentives to improve existing recycling technologies and/or develop new recycling technologies that will enable more aluminum to be recovered from scrap.

Research Opportunity

To develop new and improved technologies for the recovery of secondary aluminum utilizing scrap, furnace dross, and waste materials.

Current Status

Recycling of aluminum is a well-established industry in the United States. A variety of methods are used to recycle aluminum, depending on its source and type. New scrap can usually be sorted by alloy grade since its origin is known and its composition can be verified. Machine chips and borings have to be degreased and separated from ferrous contaminants. Reclaiming of aluminum from furnace dross, which may contain as little as 10 percent aluminum, requires specialized equipment and practices. Reclamation of old scrap is a complicated process that involves a combination of some hand sorting, shredding, magnetic separation, flotation and sweating techniques. To cut transportation costs and handling costs, most aluminum scrap is compacted prior to shipment to melting furnaces.

In general, melting of scrap aluminum is done in reverberatory furnaces, fired with natural gas or oil. These furnaces are relatively inefficient; however, the theoretical energy requirement to melt aluminum is only 457 Btu/lb and, therefore, replacement of existing equipment, which may consume as much as 3000 Btu/lb, with state-of-the-art is probably difficult to justify.

The melting operation encompasses a number of steps: (1) charging the scrap into the furnace, (2) addition of fluxes to protect the aluminum from oxidation, (3) addition of alloying elements, (4) mixing to ensure uniform chemical composition, (5) removal of magnesium by a demagging operation, (6) removal of dross, and (7) degassing to remove hydrogen.

Most of the aluminum alloys produced by the secondary aluminum industry are for castings. Since some of the scrap aluminum is high in magnesium, removal of magnesium (demagging) is required to meet specifications. Demagging is usually accomplished by feeding chlorine gas through the melt; the chlorine reacts preferentially with magnesium and exits the melt as magnesium chloride. Techniques for accomplishing this operation are well established and efficient.

Conclusion

The recycling, remelting and refining area is an area of opportunity. Development of new and improved technologies for the recovery of aluminum from scrap, furnace dross and waste materials, would increase energy efficiency and enhance competitiveness. Also, there is an opportunity to improve yield and energy efficiency in remelting operations.

Notes

(1) N.J. Jarrett, "United States Extractive Metallurgy - the 80's and Beyond," the 1986 Extrative Metallurgy Lecture, Metallurgical Transactions B Volume 18B, June 1987, p.289.

E. NEAR-NET-SHAPE CASTING

Background

In the conventional flow sheet for the production of flat rolled aluminum sheet, 16 - 30 inch thick, direct chill (DC) ingots are reheated, hot-rolled to a thickness in the range 2 - 6 mm (0.1 - 0.25 in.), edge trimmed and coiled. These casting and rolling lines are sophisticated, capable of producing a wide range of products, including material for advanced aerospace applications, at high production rates, e.g., 1.2 billion lbs/yr. However, the lines are capital intensive.

Not all flat-rolled products are produced from DC ingots. A little over 10 percent of flat-rolled products are produced from either slab casters or strip casters. In these processes, material is cast closer to the final flat-rolled product dimensions.

In the slab casting process, slabs are produced in a thickness of 12 - 25 mm (0.5 - 1.0 in.). The slabs are hot-rolled on an in-line mill to reduce the slab to coil stock, which is then used as entry material to cold-rolling mills. Consequently, several fabricating steps are eliminated, namely scalping, reheating and some hot-rolling.

In the strip casting process, strip with a nominal thickness of 6 mm (0.25 in.) is produced on twin roll casters. Solidification takes place before the roll nip and a significant amount of hot-rolling is done in the roll bite. This eliminates the need for an in-line rolling mill as required in the slab casting process line. Product from strip casters is used as entry material to cold-rolling mills.

To date, product from both slab and strip casters has been used to produce the less sophisticated products; however, there is now evidence that the pace of technical developments has quickened and applications for slab and strip product are expanding into other product lines.[1] Another emerging technology that has not been commercialized is the development of thin strip casters that produce product with thicknesses of less than 3 mm (0.1 in.).

Benefits from near-net-shape casting increase as the number of processing steps eliminated increases. The greatest potential benefits are attributable to thin strip casters in which all hot-rolling and some portion of cold-rolling may be eliminated. Since over 60 percent of the total mill products fabricated by the aluminum industry are flat-rolled products, the value of the benefits from expansion of the current slab and strip casting technology, or alternatively, the development of a thin strip casting process, will be considerable. It is estimated that the maximum possible savings from replacing current DC ingot technology (including scalping) with thin strip casting are 5 cents per pound; maximum possible benefits to the aluminum industry would be in excess of a quarter of a billion dollars per year.

Research Opportunity

To extend the application of existing near-net-shape casting processes and develop new near-net-shape processes for the production of flat-rolled products. Although casting of slabs, strip and thin strip offers the greatest value to the aluminum industry, development of near-net-shape casting processes for extruded shapes, tubes, etc. should also be considered.

Current Status

Two slab casting processes are currently used, both of which use a moving mold concept. The Hazelett caster uses water cooled steel belts and the Alusuisse Caster II employs metal chill blocks. A recent count[1] showed that 9 or 10 slab casters were operating worldwide, five of which were in the United States. Productivity from these casters is about 30 million lbs/month per caster.

Over 160 strip casters are in operation worldwide, of which 58 are in North America.[1] Production from a typical strip caster, such as the twin roll casters manufactured by Hunter Engineering, Lauener, Pechiney, Davey-McKee and Krupp is about 3 million lbs/mo. Most of the product from strip casters is used as entry material to cold-rolling mills for the production of aluminum foil.

Significant research and development activities on new and improved near-net-shape casting processes are being conducted in the U.S., Canada and many European countries. Most of the work is confidential. In addition to efforts to improve the productivity of slab and strip casters and expand the applications of cast slab and strip technology to other product lines, single wheel melt drag, single wheel planar flow and electromagnetic casting are being considered and, in some instances, actively pursued for casting sheet in thicknesses of 3 mm (0.1 in.) or less.

Conclusion

Near-net-shape casting of large-aspect-ratio shapes is an area of opportunity with large potential benefits for the aluminum industry. It is also an area in which considerable research and development has been conducted. Development of new and improved processes will increase energy efficiency and enhance competitiveness. Although casting of slab, strip and thin strip offers the greatest benefits for the aluminum industry, development of near-net-shape casting processes for extruded shapes, tubes, etc. must also be considered.

Notes

(1) R. Bachowski, R.J. O'Malley and M.M. Mahajery, "Continuous Casters for Aluminum Mini Sheet Mills." Proceedings of an International Symposium on Casting of Near-Net-Shape Products, held at the Fall Extractive and Process Metallurgy Meeting, November 13-17, 1988, in Honolulu, Hawaii.

F. MANUFACTURE OF MILL PRODUCTS

Background

The complexity of the aluminum process flow sheet increases as aluminum units move from ore, ore concentration and reduction facilities, through casting and hot-rolling to cold-rolling and specialized finishing operations. (The production of castings is considered separately in Section V.G.) At the front end of the aluminum process flow sheet, the Bayer process is the dominant method for extraction of alumina from bauxite; bauxite is the dominant commercial ore and the Hall-Heroult process is the dominant method for smelting of alumina. Thus, at the front end of the aluminum process flow sheet, the amount of material flowing through a specific process area is large and the total value added can be considerable.

Conversely, toward the finishing end of the aluminum manufacturing process, the aluminum process flow sheet diverges as many different processing routes, each with unique processing steps are required to produce a variety of flat-rolled products, extruded shapes, tubing and wire products. In consequence, the number of tons of aluminum that is produced by a particular finishing operation is much less than the number of tons produced by production facilities at the front end of the process. Although the total value added in all operations for the manufacture of aluminum mill products from solid aluminum is large, the value added in a specific process step is, in most instances, significantly less than that of process steps at the front-end of the flow sheet.

This is not meant to imply that research and development projects proposed in the manufacture of aluminum mill products area lack the potential to fulfill the purposes of the Act. This area may offer many opportunities to increase energy efficiency and enhance competitiveness. For example, yield savings and more efficient heat treatment operations can decrease energy consumption, whereas improvements in product quality, reductions in operating cost and development of new products enhance competitiveness. Identification of specific research and development opportunities that fulfill the purposes of the Act requires an indepth study of the manufacture of aluminum mill products. Because of the large number of processes involved, some of which are company-specific, DOE feels that attempting to define specific opportunities in this Research Plan is not warranted. However, it should be emphasized that the development and application of automated processing technology (see Section V.H.) to existing processes within the finishing area, including the necessary sensor development, could result in benefits in yield, energy efficiency product quality and operating cost.

Research Opportunity

No specific opportunities have been identified.

Current Status

Because of the complexity of the aluminum process flow sheet for manufacture of mill products and because of the large number of process steps involved in producing the many different aluminum products required by the aluminum consumer, no attempt is made to summarize the technologies that are either currently in use or under development.

Conclusion

Although no specific opportunities have been identified, the aluminum finishing area may offer opportunities to increase energy efficiency and enhance competitiveness, particularly through the development of automated processing technology and sensors.

G. MANUFACTURE OF CAST PRODUCTS

Background

In 1987, the aluminum industry shipped 2.055 billion pounds of castings, down slightly from the 1986 shipment level of 2.186 billion pounds. The aluminum castings industry is significantly smaller in terms of pounds of aluminum shipped than its mill product counterpart. In 1986 and 1987, mill product shipments averaged about 12 billion pounds. Although the shipment level of castings is about one sixth that of mill products, the average cost to manufacture castings is somewhat greater than that to manufacture the equivalent weight of mill products. Total sales of aluminum castings are about 4 billion dollars per year and therefore represent a significant part of the aluminum industry.

The energy consumed by the castings industry is a small part of the total energy consumed by the aluminum industry. Almost all the aluminum units used by the castings industry are produced by recycling and melting aluminum scrap. It is estimated that recovery of aluminum from scrap requires only 5 percent of the energy required to produce aluminum from ore, even though the recycled and melted scrap is usually remelted prior to casting into final products.

In 1986, the last year for which the breakdown among sand castings, permanent and semi-permanent mold castings and die castings is available, 68 percent of all aluminum castings were die cast. Permanent and semi-permanent castings totalled 18 percent and sand castings totalled 9 percent. Small amounts of other types of castings were also produced.

Die casting is a near-net-shape casting process in which the die functions as a heat exchange engine on a repetitive basis. The process is used to manufacture many different components ranging from automobile engines and transmission housings to locks, handles and parts for watches. About 50 percent by weight of aluminum die castings are used in the automotive industry.

Research Opportunity

To develop casting technologies and in particular die casting technologies that will improve yield, productivity, energy efficiency and competitiveness.

Status

As stated previously, die casting is a near-net-shape casting process. Machining of the as-cast component is required to produce final product dimensions. Development of a net-shape (as compared with a *near*-net-shape) casting process that requires little or no final machining would have significant yield, energy and cost benefits. Flow characteristics of molten aluminum into and within the die need to be better understood; technology also needs to be developed for improved thermal control of the die. In addition, improvements in riser technology would improve yield.

Yield and energy improvements are also possible in the remelting of aluminum for all types of castings. It is common for yield losses in melting and remelting to be as much as 10 percent. Since much of the loss is due to oxidation of the aluminum to alumina, this loss cannot be easily recovered. However, practices are available to recover the aluminum metal contained in the dross.

Conclusion

There is an opportunity to increase energy efficiency and enhance competitiveness in the manufacture of aluminum cast products, particularly in the die casting area. However, it is difficult to envision that projects in this area will have the potential to make a major impact on the aluminum industry when compared with benefits that may be obtained in other areas, such as the Hall-Heroult cell.

H. AUTOMATED PROCESSING TECHNOLOGY

Background

The area of automated processing technology and computer technology affects all process areas within the aluminum flow sheet. Computers are already being used in the aluminum industry for process control and to perform many business functions with demonstrated savings in materials, labor and energy. However, the use of computer technology has the potential to effect further cost savings and quality improvements through the effective utilization of information. Specifically, the application of artificial intelligence, and the development of expert systems for process and inventory control, production scheduling and customer service are necessary investments that the domestic aluminum industry must make if it is to improve energy efficiency and enhance competitiveness. Development of new sensors may be an integral part of the development of automated processing technology.

Potential benefits in this area are difficult to assess. Since almost all, if not all, process areas within the aluminum flow sheet could be effected by the application of artificial intelligence and the development of expert systems, benefits could be substantial. In a sense, every dollar of value added in the aluminum process flow sheet is a potential target for elimination by automated processing technology.

Research Opportunity

To develop automated processing technology, including application of computer technology, artificial intelligence and the development of expert systems, to all aspects of the aluminum process flow sheet, to production scheduling, business planning and customer service. Sensor development should be an integral part of this effort.

Current Status

It is difficult for DOE to assess the extent of the research and development efforts in this area by individual companies within the aluminum industry. It is possible that individual companies have significant efforts in this area; however, DOE is unaware of the objectives and accomplishments of specific research and development programs.

Conclusion

Automated processing technology, including the application of computer technology and artificial intelligence and the development of expert systems, is an area of opportunity for funding under the Act. Development of new sensors may be required. Benefits from automated processing technology could be substantial.

I. ENVIRONMENTAL

Background

In the Act, the Secretary of Energy was directed to consider a number of research areas for possible inclusion in the Aluminum Research Plan. With the exception of two areas, all the areas mentioned in the Act have been considered in prior sections of this Plan (see Sections V.B. through V.I.).

The exceptions are:

(1) The development of technologies and equipment related to the production of aluminum that enhance the protection of the environment and the safety and health of workers.

(2) The treatment and storage of waste materials and other by-products from aluminum production and processing.

Both of these areas can be classified under the general category, Environmental.

The aluminum industry has the potential to do damage to the environment. Large quantities of impure raw materials are handled and smelted at elevated temperatures, giving rise to a variety of effluents. Potential sources of emissions to the air include gaseous fluorides from the Hall-Heroult cell, chlorides from demagging operations, particulate matter from degassing, remelting and casting operations and dust from handling of raw materials and from disposal sites. The potential sources of water pollution include waste waters and liquors from many of the operations mentioned previously; additional sources include waters from rolling operations and finishing operations. Significant quantities of waste materials are also generated, for example, red mud from the Bayer process and spent pot-liners from the Hall-Heroult process. In addition, liquid aluminum is a very reactive material subject to explosions if handled incorrectly.

The technology in place today provides a high degree of safety and environmental protection by capturing emissions to the air, removing pollutants from waste water and either controlling releases from waste materials or converting them into a non-hazardous waste. However, the costs are large in terms of capital investment and operating costs.

Research Opportunity

To develop innovative, cost effective solutions to environmental and safety problems and to recover energy and/or materials from waste products, such as red mud and spent pot-liners and to reduce the amount of material requiring capture or treatment.

Current Status

The aluminum industry utilizes a broad range of facilities and operating practices to remove particulate matter and gaseous contaminants from gaseous streams, to remove suspended solids and chemical contaminants from aqueous streams, to treat waste products in an environmentally sound manner and to ensure the safety of workers. Because of the many different facilities and processes employed in the aluminum industry to solve environmental and safety problems, no attempt is made to summarize the technologies that are either in use or under development.

However, there are three areas that will be discussed briefly; these are red mud disposal, spent pot liner disposal and the risk of explosions when handling liquid aluminum.

Red mud is generated in the Bayer process in the clarification step when the sodium aluminate solution is separated from solid materials by a process of filtration and sedimentation. It is estimated that several million tons of red mud are generated in the United States each year. The red mud is pumped as a slurry into specially constructed disposal areas. As the red mud dries out, water spraying is necessary to control wind-blown dust.

Ideally, red mud should not be considered a waste material, since it is rich in iron oxide, titanium oxide and other minerals. It is already in a finely ground state, so the first step in ore concentration and metal extraction has been performed. However, no economic process has been developed to recover materials from red mud.

During the course of operation of the Hall-Heroult cell, the cathode carbon becomes contaminated with fluorides, sodium cyanide and other materials. Under recent regulations, these cathode pot-liners have been classified as a hazardous waste, and can no longer be placed in conventional landfill sites. Aluminum companies that operate Hall-Heroult cells have to either dispose of these liners in approved sites, recycle or stabilize this carbonaceous material. At the present time, there is no generally accepted technology that treats spent pot-liners as a by-product material from which energy and materials can be recovered. Recovery, reuse and disposal methods have been investigated by all major aluminum producers, either individually, or collectively through the Aluminum Association. Methods that have been studied are pyrohydrolysis, pyrosulfolysis, caustic leach, sulfuric acid leach and reuse of pot-lining as a substitute for spar in iron and steelmaking.[1]

In 1981, the Aluminum Association, after an industry workshop, sponsored a Fluidized Bed Combustion process at GA Technologies in San Diego. The project failed to reach the demonstration stage.

A third area that merits attention is a better understanding of the conditions that cause explosions during casting of liquid aluminum.

Conclusions

The environmental area offers some opportunities to increase energy efficiency and enhance competitiveness. However, it is difficult to envision projects in the environmental area that will have a major impact on the energy efficiency and competitiveness of the aluminum industry.

Notes

1. Aluminum Industry Scoping Study published by the Center for Metals Production, August, 1986.

J. CONCLUSIONS -- ALUMINUM

The objective of the Aluminum Research Plan is to identify and establish priorities for research and development opportunities that can increase the energy efficiency and enhance competitiveness of the American aluminum industry. All major process areas have been analyzed where there is an opportunity to increase energy efficiency and enhance competitiveness. In addition, other areas suggested in the Act have been considered.

Of the process areas selected for analysis, the production of aluminum from alumina is the process area where the opportunity to fulfill the purposes of the Act is highest. The value added in this area and potential benefits are very large, and clearly defined research and development opportunities exist.

Near-net-shape casting, particularly near-net-shape casting of large-aspect-ratio shapes, is also a high opportunity area for funding under the Act. Benefits in this area are potentially large and clearly defined research and development opportunities exist.

Automated processing technology, including the required development of sensors, should be considered an opportunity area; development work in this area could effect all phases of the aluminum flow sheet. Although benefits in this area could be significant, specific research and development opportunities have not, to DOE's knowledge, been defined.

In the recycling, remelting and refining area, research and development programs could increase energy efficiency and enhance competitiveness. Specific opportunities are to develop new technologies to recover aluminum from scrap and improve yield during remelting.

There is probably some opportunity to increase energy efficiency and enhance competitiveness in the alumina production area, the manufacture of aluminum cast products area, the environmental area and the manufacture of aluminum mill products. However, it is difficult to envision projects in these areas that have the potential to make a major impact on the aluminum industry when compared with the benefits that may be obtained from the high opportunity areas.

VI. COPPER RESEARCH PLAN

Background

The United States is one of the largest producers of copper from mined ore. In 1987, the U.S. mine production of recoverable copper, 1.4 millions tons, was exceeded only by Chile, 1.5 million tons. Other large producers include the USSR, 1.1 million tons, and Canada 0.8 million tons. Several countries, Peru, Zaire and Zambia, produced about 0.5 million tons. Total world production of copper from ore in 1987 was over 9 million tons. Of the 1.4 million tons of U.S. mine produced copper, over 100,000 tons were exported as ore.

In 1987, almost 3.4 million tons of copper were consumed in the United States, of which about 0.5 million tons (16 percent) was imported as refined copper. Production of copper from ore in the United States totalled 1.3 million tons and copper recycled from scrap totalled 1.4 million tons. (Inventory changes, etc. accounted for about 0.1 million tons). In 1987, smelter production accounted for 86 percent of the 1.3 million tons of primary copper. The remaining 14 percent was produced by hydrometallurgical processing, which is becoming an increasingly important alternative to smelting, particularly for non-sulfide ores.

Most of the domestic copper ore for smelting is mined in Arizona. Significant quantities are also mined in Utah and New Mexico. Domestic copper ores are usually low grade sulfide ores, averaging less than 0.7 percent copper.[1] Mining is from open pit mines requiring the removal of significant quantities of overburden. The ore is crushed, ground and concentrated, usually by flotation, to yield a concentrate containing 20 to 30 percent copper. The concentrate is smelted in a reverbatory furnace to produce a copper sulfide-iron sulfide matte containing 50 to 75 percent copper. In the next step, converting, the matte is oxidized, resulting in the formation of an iron oxide slag, sulfur dioxide and blister copper (98.5 percent pure). The blister copper is then refined to 99.5 percent purity.

In the hydrometallurgical process, copper is first leached out of ores or waste dumps, by percolating weak acids through the copper bearing materials. The aqueous solution is collected and copper recovered electrolytically (electrowinning). This method of primary copper production has reduced the cost of copper production by as much as $0.11/lb.[1]

As in the case of both steel and aluminum, the process flow sheet for copper increases in complexity as copper is fabricated into a variety of products for a wide range of applications. Although the value added in these fabricating steps is probably a significant part of the total value added by the copper industry, it is difficult to envision projects in the fabrication area that have the potential to make a significant impact on the copper industry.

Research Opportunity

To develop new and improved processes for the extraction of copper from domestic ores.

Status

The status and research opportunity for the production of copper has been summarized in a recent report by the Office of Technology Assessment.[1]

> *Because technology transfer is almost instantaneous in the copper industry, the first place to search for a technological advantage is in resources or aspects of production that are common in the United States but rare elsewhere. For example, North America has copper oxide ore bodies that are particularly suitable for leaching and solvent extraction-electrowinning. The lowest cost copper (<30 cents/lb) currently is produced using this technology in combination with mine waste dumps containing very low-grade resources, but for which the mining cost has already been incurred. However, research is underway on methods to leach ore in place (i.e., without ever having to mine it). When developed and proven in the field, in situ solution mining could provide a significant cost advantage for the U.S. industry. Labor-saving innovations also would benefit the domestic industry because our labor costs are so high. While these innovations could be copied elsewhere, the relative advantage would not be so great.*
>
> *The U.S. industry also is at a disadvantage in materials handling: mines have to haul more ore because of our lower ore grades. The combined energy, labor, and other costs make our transportation charges very high. Some mines are replacing trucks with conveyor systems coupled with in-pit ore crushing machines. While this technology is likely to be applied wherever in the world electricity is cheaper than diesel fuel, it benefits U.S. mines because of our high truck haulage costs. A more radical technological cost-saver might use artificial intelligence to develop some form of "driverless truck."*

Conclusion

There is an opportunity to develop new and improved technologies for the extraction of copper from domestic ores that would increase energy efficiency and enhance competitiveness. A specific opportunity is the application of solvent-extraction and electrowinning technologies to *in situ* ores.

Notes

(1) "Copper-Technology and Competitiveness" issued by the Office of Technology Assessment, Congress of the United States, September 1988.

STEEL AND ALUMINUM ENERGY CONSERVATION AND TECHNOLOGY COMPETITIVENESS ACT OF 1988

MANAGEMENT PLAN

Office of Industrial Programs
Office of Conservation and Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

May 1989

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STEEL AND ALUMINUM ENERGY CONSERVATION AND TECHNOLOGY COMPETITIVENESS ACT OF 1988

MANAGEMENT PLAN

INTRODUCTION

The Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988 was signed by President Reagan on November 17, 1988. This Act, Public Law 100-680 (see Appendix A), hereinafter referred to as the "Act", has the following purposes:

(1) to "increase the energy efficiency and enhance the competitiveness of American steel, aluminum, and copper industries...," and

(2) to continue steel research and development efforts begun under the Department of Energy (DOE) program known as the Steel Initiative.

The Act directs the Secretary of Energy to "reestablish an industrial energy conservation and competitive technology program to conduct scientific research and development of steel and aluminum technologies to carry out the purposes of this Act." This Management Plan provides a framework for program implementation. The intent of Congress, as indicated in the legislation and committee reports, as well as DOE policies and operating practices, have been considered in developing this Plan.

Prior to signing of the Act, steel research and development activities conducted in response to the Steel Initiative had been managed in accordance with the Management Plan published by DOE on April 1, 1987. This revised Management Plan was written using the previous Plan as a point of departure. Its provisions apply to all proposals received by DOE after November 17, 1988, for research and development work directed toward the purposes of the Act. It is not necessary to refer to the Plan of April 1, 1987, for any current requirements. This revised Management Plan does not include a research agenda. The Research Plan required by this Act will be published separately by DOE.

PROGRAM MANAGEMENT

The purpose of this section is to generally define the roles and responsibilities of the organizations involved in implementing the Act -- including the Federal Government, the National Laboratories, industry, and universities. Other objectives are to provide information on non-Federal cost sharing and to identify organizational and administrative procedures involved in the conduct of this program.

Within the Department of Energy, the responsibility for management of this program is assigned to the Director, Office of Industrial Programs (OIP), a program office within

Conservation and Renewable Energy. OIP has identified roles and responsibilities for several parties as outlined below.

1. DOE/HQ Office of Industrial Programs

- Overall program management and direction, including development of multi-year plans with sufficient rationale to support agency budget documents;
- Coordination of research and development programs with other elements within DOE and other Federal agencies;
- Analyses, overviews, and recommendations to the Office Director, Deputy Assistant Secretary, and Assistant Secretary regarding program requirements, issues resolution, and management;
- Coordination with the domestic steel, aluminum, copper, and other metals industries, and other entities outside DOE, to obtain recommendations and viewpoints on program implementation;
- Receipt and processing of solicited and unsolicited proposals for formal review from sources other than DOE National Laboratories;
- Preparation of an annual report on the status of research and development activities at the end of each fiscal year;
- Identification and acquisition of assistance from other DOE organizational elements as appropriate;
- Decisions on funding of research and development projects;
- Evaluation of technology transfer efforts;
- Initiation of documentation required to obligate appropriated funds; and
- Development and updating of the Research Plan.

2. DOE Idaho Operations Office

The Idaho Operations Office (ID) of DOE is the primary field office providing assistance in executing projects approved for funding under this Act by the Office of Industrial Programs. ID is responsible for:

- Solicitation, receipt, and coordination of the evaluation of Field Work Proposals (FWPs) from DOE National Laboratories, consistent with guidance and direction from DOE headquarters;

- Implementation and monitoring of research projects after receipt of funding documentation from DOE Headquarters, consistent with applicable laws, Federal regulations, and DOE policies; this includes formal approval of FWPs and negotiation of financial assistance instruments as appropriate;

- Obligation of DOE funds appropriated in support of this Act in response to decisions of DOE headquarters;

- Tracking and technical reviews of progress on research and development projects;

- Providing recommendations on program modifications;

- Administration of agreements entered into with National Laboratories and other entities conducting research;

- Execution of Memoranda of Understanding with other cognizant DOE Field Offices as necessary;

- Modification of project agreements as required; and

- Contractual and administrative arrangements with EG&G Idaho, Inc. (EG&G) for technical support of research activities supported by this program.

3. EG&G Idaho, Inc.

EG&G Idaho, Inc., a management and operating contractor for the Department of Energy at the Idaho National Engineering Laboratory (INEL), will provide technical and administrative support to ID. EG&G will provide the following types of services:

- Proposal reviews, other than proposals submitted by INEL;

- Recommendations on project modifications, based on ongoing technical monitoring of R&D in progress;

- Periodic oral and written documentation on the status, issues, and problems associated with research activities; and

- Assistance with the transfer of research results.

These functions will not be performed by EG&G for proposal and/or project activities involving the INEL. In such cases, OIP will engage the support of other qualified organizations.

4. Private Industry

Involvement of private industry is an essential element of the program authorized by the Act. Research and development supported under this program must include substantial cost sharing participation by domestic companies that are potential users of the resulting technology. Participation by suppliers of equipment is encouraged. According to the Act, the term "domestic company" means a company "which is substantially involved in the United States domestic production, processing, or use of steel, aluminum, copper, or other metals and has a substantial percentage of its operations located within the United States."

Private industry is expected to take a leadership position in the development of research proposals. Industry leadership may be manifested either by organizing and conducting specific projects within industrial facilities, or by participating in research and development projects conducted by other research organizations. After a decision is made to fund a specific project, the prime contractor will be responsible for:

- Conducting the research in a professional, purposeful manner;
- Awarding subcontracts as appropriate;
- Providing technical materials required for processing patent applications resulting from its research;
- Management of efforts necessary to achieve project objectives identified in the proposed Statement of Work or otherwise as agreed upon between DOE and the proposer; and
- Periodic research and progress reports to DOE.

5. DOE National Laboratories

The National Laboratories are recognized as a source of broad, generalized technical expertise which is available to support research and development efforts directed toward the goals of the Act. National Laboratories are encouraged to prepare and submit FWPs directed toward areas of opportunity identified by the Research Plan. FWPs are subject to the same requirements and criteria as all other proposals submitted in response to this program. Research and development funded in response to an FWP need not be conducted entirely at the National Laboratory facilities, depending on the nature of the work. DOE encourages the use of existing facilities, whether in industry, at National Laboratories, or elsewhere, to minimize the time and expense associated with construction of new facilities.

6. Universities

The Act's legislative history notes the important contributions which have been made by the nation's universities. For each research activity, the contractor will determine supporting research, if any, which could best be performed at a university. Universities located in the United States may also submit proposals directly for consideration by DOE.

7. Other Entities

Other Federal agencies, state agencies, research institutes, not-for-profit organizations, industry associations, and professional societies may also submit research proposals for work consistent with the purposes of the Act, and may cost share and be participants in research projects. The research agenda developed by DOE will be coordinated with research and development activities of the National Institute of Standards and Technology and other Federal agencies.

DOE National Laboratories, universities, and other entities which serve in the capacity of a lead laboratory or prime contractor will have the same responsibilities as those identified in the section above on "Private Industry."

PROJECT REQUIREMENTS

1. Cost Sharing

The Act requires that for research and development proposals received after November 17, 1988, "the non-Federal financial share shall equal at least 30 percent of the total cost of any project." Cash, personnel, equipment, and facilities contributed by industry may be included in cost sharing. Existing facilities, equipment, supplies, personnel, and other property may be included in the non-Federal cost share of a project only when they are directly relevant to the project, that is, those required to accomplish the objectives of the project. The value of all non-cash cost sharing will be determined by DOE prior to project funding approval, in accordance with guidance in the DOE Assistance Regulations.

Research projects may consist of a single phase or contain several proposed phases. A definitive description of all proposed work in one or more phases with accompanying estimated costs must be given. Cost sharing must accompany each phase. Additional participants may join a project at any time with the approval of the current participants.

Entities that cost share in research conducted in accordance with the Act will become *participants*, eligible for the following benefits relative to those activities in which they elect to cost share:

- Immediate and continuing access to research results,
- The opportunity to receive a royalty-free license to resulting technologies, and
- A share of the royalties received from non-participating companies.

2. Proposal Preparation Considerations

Projects must have the potential to make a significant impact on the energy efficiency and competitiveness of the steel, aluminum, copper, or other metals industries. Proposals for projects to be funded by the program must address the following requirements.

1. The proposed research and development is consistent with the purposes of the Act;
2. The initial phase of a proposed effort may be laboratory, bench-scale, or pilot-scale research; the final phase will ordinarily be pilot-scale research;
3. A critical review of existing and emerging technologies, patents, on-going research, and practices, on a world-wide basis, that are and/or could be competitive with the proposed new technology. The hurdles that must be overcome to ensure commercial viability must be identified;
4. (a) An initial economic evaluation indicating the potential for a significant reduction in manufacturing costs and/or a significant improvement in product value due to an improvement in product characteristics, and (b) an estimate of the economic benefit to the domestic metals industry;
5. An estimate of the potential energy savings attributable to the implementation of the technology expected to result from the R&D;
6. A Statement of Work for achieving the stated project objective, including project schedule, work breakdown structure, spending plan, milestones, and decision points;
7. Identification and qualifications of the principal research personnel and equipment involved in the effort;
8. Non-Federal cost sharing commitment. There is a legislative requirement that non-Federal cost sharing must equal at least 30 percent of the total cost of any project;
9. An estimate of the total R&D costs required to reach the stage of technology development at which Federal funding will no longer be required; and

10. A plan for commercialization, including timing, given successful accomplishment of R&D objectives.

DOE will publish changes to these requirements as appropriate in the *Federal Register* and *Commerce Business Daily*.

3. Proposal Review and Evaluation

Procedures for proposal review and evaluation will depend on whether the submission responds to a formal solicitation or is unsolicited. An unsolicited proposal is an independently originated written request developed by an offeror for DOE support of an innovative or unique project, which is submitted without a written solicitation issued by DOE. Unsolicited proposals submitted for funding under the Act will be handled according to the procedures described in the DOE publication "Guide for the Submission of Unsolicited Proposals." The proposed research and development work will be reviewed by DOE personnel and, if deemed appropriate, will be referred for detailed evaluation. The principal elements that will be considered in evaluating a proposal are:

1. Overall scientific, technical and/or socioeconomic merit of the proposed activity;
2. The scientific and technical competence of the proposer and supporting institution(s) and the adequacy of necessary facilities;
3. The relevance of the proposed research project to the purposes of the Act; and
4. The appropriateness of proposed costs, including cost sharing.

Details of the review and evaluation procedure for solicited proposals will be given in the formal solicitation notice.

PROTECTION OF INTELLECTUAL PROPERTY

The knowledge resulting from research and development efforts conducted under this Act shall be developed for the benefit of the domestic companies which provide financial resources to the program. It is DOE's intention to immediately transfer title to all resulting intellectual property to a holding company selected by the project's participants.

For each project, an entity or holding company will be created or designated by the project's participants for the purpose of holding patents and licensing technology. Title to all patents resulting from research authorized by the Act will be available to the holding company as a result of the Statement of Analysis and Determination of Exceptional Circumstances for DOE Funding Agreements Relating to the U. S. Department of Energy Steel Initiative issued on June 3, 1987, and the provisions of an advance waiver of the Government's U.S. and Foreign Patent Rights. This method of handling intellectual property is intended to serve the dual purposes of facilitating technology transfer to the market place and providing benefits to project participants.

DOE expects every effort to be made by the holding companies to secure patent protection for the technology developed for each project. Prior to filing for patent coverage, information concerning inventions developed under this program will be held in confidence among DOE and the project participants, and will not be subject to dissemination under the requirements of the Freedom of Information Act (FOIA) to the extent authorized by 35 U.S.C. 205. After patents have been issued, dissemination of this information will not be restricted.

Information supplied on a confidential or privileged basis by one or more participants, including trade secrets and commercial and financial information as defined under section 552(b)(4) of title 5, United States Code, will be protected. Requests made for such information will be forwarded to the provider(s) of such information for review.

Data and other technical information generated during the conduct of research funded by this Act which are not included in the previous categories, and which would be a trade secret or commercial or financial information and privileged or confidential under the meaning of section 552(b)(4) of title 5 of the United States Code if obtained from a domestic company, will generally be made available to the public unless one or more participants and DOE determine that the information should be withheld from dissemination for the benefit of the participants; such information will not be disseminated for five years (P.L. 100-680, section 4(b)(4)). Information released by any participant or other source to any non-participant may cause that information to be publicly available. Periodic research reports furnished to DOE in fulfillment of contractual requirements will be readily available to the public, with no restriction on distribution. Likewise, technical papers presented in the public domain will have unrestricted availability.

Participants in a project and the United States Government will receive a fully-paid-up, royalty-free license from the holding company to all patents generated by the project. Participants will not have the right to sub-license except as necessary for the sale of products or equipment. Holding companies must make available nonexclusive licenses on reasonable terms and conditions to practice technology developed under this Act to all responsible domestic companies that do not participate in a project. Royalties and other fees obtained through the sale and/or licensing of intellectual property will be distributed among the participants, the holding company, research organizations, and inventors, and the Federal Government, according to the agreements among these parties.

APPENDIX

Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988

Public Law 100-680
100th Congress

An Act

To promote energy conservation and technology competitiveness in the American steel and aluminum industries.

Nov. 17, 1988
[S. 2470]

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988.
Research and development.
15 USC 5101 note.

SECTION 1. SHORT TITLE.

This Act may be cited as the "Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988".

SEC. 2. FINDINGS AND PURPOSES.

15 USC 5101.

(a) FINDINGS.—The Congress finds that—

(1) maintaining viable domestic steel, aluminum, copper, and other metals industries is vital to the national security and economic well being of the United States; and

(2) the promotion of technology competitiveness and energy conservation in the American steel and aluminum industries by the Federal Government through a program of joint research and development will help maintain viable domestic steel and aluminum industries.

(b) PURPOSES.—The purposes of this Act are to—

(1) increase the energy efficiency and enhance the competitiveness of American steel, aluminum, and copper industries by providing Federal incentives for the establishment of public-private sector research and development partnerships to undertake scientific research and development to develop advanced technologies utilizing the expertise of the steel, aluminum, copper, and other metals industries, Government-owned laboratories of the Department of Energy and the National Institute of Standards and Technology, universities, State development agencies, and others; and

(2) continue steel research and development initiative efforts begun under title II of the Interior and Related Agencies portion of the joint resolution entitled "Joint Resolution making further continuing appropriations for the fiscal year 1986, and for other purposes", approved December 19, 1985 (Public Law 99-190).

SEC. 3. DEFINITIONS.

15 USC 5102.

As used in this Act—

(1) the term "Secretary" means the Secretary of Energy;

(2) the term "domestic company" means a company which is substantially involved in the United States domestic production, processing, or use of steel, aluminum, copper, or other metals and has a substantial percentage of its operations located within the United States;

(3) the terms "management plan" and "plan" mean the Steel Initiative Management Plan issued on April 1, 1987, by the Department of Energy, which establishes the management

framework for the steel research and development initiative, and updates to that plan; and

(4) the term "research plan" means the Steel Initiative Research Plan issued in April 1988 by the Department of Energy, and updates to that plan.

15 USC 5103.

SEC. 4. ESTABLISHMENT OF SCIENTIFIC RESEARCH AND DEVELOPMENT PROGRAM TO DEVELOP COMPETITIVE MANUFACTURING TECHNOLOGIES AND INCREASE ENERGY EFFICIENCY IN THE STEEL AND ALUMINUM INDUSTRIES.

(a) General Authority.—The Secretary, pursuant to the authority provided under provisions of the Federal Nonnuclear Research and Development Act of 1974 (42 U.S.C. 5901, et seq.), shall reestablish an industrial energy conservation and competitive technology program to conduct scientific research and development of steel and aluminum technologies to carry out the purposes of this Act. Such program shall provide the financial and technical assistance and other incentives which, in the judgment of the Secretary, are necessary to carry out the purposes of this Act.

(b) Management Plan.—Within 6 months after the date of enactment of this Act, the Secretary shall publish an update of the management plan to expand the steel research and development initiative to include aluminum and to carry out the purposes of this Act. The Secretary, from time to time, may further update the management plan. The management plan shall be subject to the following conditions:

(1) For newly initiated research and development proposals submitted under the revised management plan, the non-Federal financial share shall equal at least 30 percent of the total cost of any project.

(2) Existing facilities, equipment, supplies, and other property may be included in the non-Federal share under this section only when they are directly relevant to the project.

(3) The knowledge resulting from research and development activities conducted under this Act shall be developed for the benefit of the domestic companies who provide financial resources to the program.

Classified information.

(4) The Secretary, for a period of up to 5 years after the development of information that—

(A) results from research and development activities conducted under this Act; and

(B) would be a trade secret or commercial or financial information that is privileged or confidential, as described in section 5(a), if the information had been obtained from a domestic company,

may provide appropriate protections against the dissemination of such information, including exemption from subchapter II of chapter 5 of title 5, United States Code.

(5) The plan shall assure basic research support, for the research carried out under the research plan, from independent laboratories, universities, and nonprofit organizations, by coordinating activities under the research plan with the basic research efforts of the Department of Energy, such as the Energy Conversion and Utilization Technologies Program and the Materials Processing and Sensor and Controls programs within the Office of Industrial Programs.

(c) PRIORITIES.—Within 6 months after the date of enactment of this Act, the Secretary shall publish an update of the research plan. In reviewing research and development activities for possible inclusion in the research plan, the Secretary shall consider the following:

(1) STEEL PROJECTS.—

(A) The direct production of liquid steel from domestic materials.

(B) The production of near-net shape forms from liquid, powder, or solid steel.

(C) The development of universal grades of steel.

(D) The application of automatic processing technology.

(E) The removal of residual elements from steel scrap.

(F) The treatment and storage of waste materials and other byproducts from steel production and processing.

(G) The development of super-plastic steel processing.

(H) The development of advanced coatings for sheet steels.

(I) The development of technologies and equipment related to the production of steel that enhance the protection of the environment and the safety and health of workers.

(J) Other steel technologies which, in the judgment of the Secretary, further the purposes of this Act.

(2) ALUMINUM AND OTHER PROJECTS.—

(A) The production of aluminum.

(B) The application of automatic processing technology.

(C) The treatment and storage of waste materials and other byproducts from aluminum production and processing.

(D) The manufacture of aluminum mill products.

(E) Aluminum recycling technologies.

(F) The development of technologies and equipment related to the production of aluminum that enhance the protection of the environment and the safety and health of workers.

(G) Aluminum, copper, and other metals technologies which, in the judgment of the Secretary, further the purposes of this Act.

(d) INDUSTRY PARTICIPATION AND REVIEW.—The Secretary shall arrange for participation and review by representatives of each affected industry and by labor in the updating of the management and research plans and in the evaluation of the progress of research and development activities for their industry conducted under this Act.

SEC. 5. PROTECTION OF PROPRIETARY RIGHTS. 15 USC 5104.

(a) PROPRIETARY RIGHTS.—No trade secrets or commercial or financial information that is privileged or confidential, under the meaning of section 552(b)(4) of title 5, United States Code, which is obtained from a domestic company shall be disclosed in the conduct of the management plan or research plan, or as a result of activities under this Act. Classified information.

(b) PATENT RIGHTS VESTED IN THE UNITED STATES.—All patent rights from inventions developed under the management plan or the research plan implemented pursuant to this Act shall be vested in accordance with section 9 of the Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C. 5901).

15 USC 5105.

SEC. 6. COORDINATION.

The Secretary shall coordinate the research and development conducted under this Act with other research and development being conducted by the Department of Energy and other Federal agencies in order to increase efficiency and avoid duplication of effort.

15 USC 5106.

SEC. 7. EXPANDED STEEL AND ALUMINUM RESEARCH PROGRAM IN NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY.

The National Institute of Standards and Technology, through its Institute for Materials Science and Engineering and, as appropriate, in coordination with the Department of Energy and other Federal agencies, shall conduct an expanded program of steel and aluminum research to provide necessary instrumentation and measurement research and development in support of activities conducted under this Act.

15 USC 5107.

SEC. 8. REPORTS.

The Secretary shall prepare and submit annually to the President and the Congress at the close of each fiscal year a complete report of the research and development activities carried out under this Act during the fiscal year involved, including the actual and anticipated obligation of funds, for such activities, together with such recommendations as the Secretary may consider appropriate for further legislative, administrative, and other actions, including actions by the American steel, aluminum, copper, and other metals industries, which should be taken in order to achieve the purposes of this Act. The report submitted at the close of fiscal year 1991 shall also contain a complete summary of activities under the management plan and the research plan from the first year of their operation, along with an analysis of the extent to which they have succeeded in accomplishing the purposes of this Act.

15 USC 5108.

SEC. 9. AUTHORIZATION OF APPROPRIATIONS.

(a) To THE SECRETARY.—(1) There are authorized to be appropriated to the Secretary, to carry out the functions of the Department of Energy under this Act, $2,000,000 for fiscal year 1989, $20,000,000 for fiscal year 1990, and $25,000,000 for fiscal year 1991.

(2) Funds previously appropriated for the steel research and development initiative—

(A) under title II of the Interior and Related Agencies portion of the joint resolution entitled "Joint Resolution making further continuing appropriations for the fiscal year 1986, and for other purposes", approved December 19, 1985 (Public Law 99-190); or

(B) under subsequent appropriation Acts,

which remain available under the terms of such Acts may be used for the purposes of this Act.

(b) To THE INSTITUTE.—There are authorized to be appropriated to the Director of the National Institute of Standards and Technology to carry out the functions of the Institute under this Act, $3,000,000 for each of the fiscal years 1989, 1990, and 1991.

15 USC 5109.

SEC. 10. RELATION OF EXISTING PROGRAM.

Proposals received by the Department of Energy before the date of enactment of this Act may be carried out without regard to changes in the management plan and research plan required by this Act.

SEC. 11. DRUG-FREE WORKPLACE.

15 USC 5110.

(a) No department, agency, or instrumentality of the United States receiving funds authorized to be appropriated under this Act for fiscal year 1989, fiscal year 1990, or fiscal year 1991, or under any other Act authorizing appropriations for fiscal year 1989, fiscal year 1990, or fiscal year 1991, shall obligate or spend any such funds, unless such department, agency, or instrumentality has in place, and will continue to administer in good faith, a written policy designed to ensure that all of its work places are free from the illegal use, possession, or distribution of controlled substances (as defined in the Controlled Substances Act) by the officers and employees of such department, agency, or instrumentality.

(b) No funds so authorized to be appropriated to any such department, agency, or instrumentality shall be available for payment in connection with any grant, contract, or other agreement, unless the recipient of such grant, contract, or party to such agreement, as the case may be, has in place and will continue to administer in good faith a written policy, adopted by such recipient, contractor, or party's board of directors or other governing authority, satisfactory to the head of the department, agency, or instrumentality making such payment, designed to ensure that all of the workplace of such recipient, contractor, or party are free from the illegal use, possession, or distribution of controlled substances (as defined in the Controlled Substances Act) by the officers and employees of such recipient, contractor, or party.

Approved November 17, 1988.

LEGISLATIVE HISTORY—S. 2470

HOUSE REPORTS: No. 100-1061 (Comm. on Science, Space, and Technology).
SENATE REPORTS: No. 100-443 (Comm. on Energy and Natural Resources).
CONGRESSIONAL RECORD, Vol. 134 (1988):
    Aug. 9, considered and passed Senate.
    Oct. 12, considered and passed House, amended.
    Oct. 21, Senate concurred in House amendment.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 24 (1988):
    Nov. 17, Presidential statement.

REFERENCES

The following statutory authorities and relevant orders are applicable to the provisions of this management plan:

1) Title 48 CFR Chapter I, The Federal Acquisition Regulation (FAR)
2) Title 48 CFR Chapter 9, The Department of Energy Acquisition Regulation (DEAR)
3) Title 10 CFR Part 600, The Financial Assistance Rule
4) Financial Assistance Procedures Manual (FAPM) DOE 4600.1A
5) Guide for the Submission of Unsolicited Proposals
6) DOE 5700.7B, WORK AUTHORIZATION SYSTEM and Change 2 dated 3/9/89

Copies of these documents are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Mr. SCHEUER. Thank you, Mr. Streb.

We will have questions after we hear from Dr. Lyle Schwartz, Director of the Materials Science and Engineering Laboratory at the National Institute of Standards and Technology at Gaithersburg.

Please proceed, Dr. Schwartz.

STATEMENT OF DR. LYLE H. SCHWARTZ, DIRECTOR, MATERIALS SCIENCE AND ENGINEERING LABORATORY, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Dr. SCHWARTZ. Mr. Chairman, Mr. Ritter, I thank you for this opportunity to describe some of the activities and accomplishments of the National Institute of Standards and Technology's Materials Science and Engineering Laboratory in support of the U.S. metals industries.

I would like to open my remarks by pointing out that the interaction between NIST and the steel industry is one of long standing, based on generic research at NIST closely coupled to the current needs of the industry. For more than 80 years, the National Institute of Standards and Technology has been working with the steel industry to improve the durability and performance of metals and alloys.

Throughout NIST's history, as in this steel effort, cooperative activities with industry have been carried out with costs co-shared by NIST and the industrial participant. In these formal cooperative agreements between NIST and industrial organizations, the industry investment has been in the form of dollars, equipment, and materials, or scientific personnel, characterized by us as Industrial Research Associates.

Since the early 1980s, NIST has been collaborating with the steel industry to develop process control sensors to improve productivity and product quality. The NIST/AISI program developed broadly applicable measurement methods for the rapid, on line detection of porosity in steel. In 1987 this porosity detection system received an award from Industrial Research Magazine as one of the 100 most significant technical products of the year, and the system is now commercially available.

In temperature sensing, the challenge was to develop a non-intrusive sensor to measure the internal temperature distribution in hot metal. NIST and AISI member company researchers, working with Pacific Northwest Laboratories and sensor vendor companies, have developed an integrated temperature measurement system based on ultrasonic and laser techniques. The measurement system has successfully passed field trials in a steel mill environment and has directly led to a research spin-off to new sensor technology for the aluminum industry.

Building on the existing collaborative efforts with the steel industry, NIST in 1986 expanded its program beyond sensor development. Current focus is directed toward sensor development, data and measuring techniques for processing, and data for metals refining and characterization.

Looking to the future, NIST continues to interact with the metals industry through research planning activities, and updates the technical content of the NIST program to reflect changes in research needs. Advanced manufacturing techniques increasingly demand materials of greater reliability and uniformity at competitive cost. Specific demands for properties and performance can be met by control of the processing of the materials from synthesis or raw material production to forming and finishing. Such process control, or "intelligent processing of materials"—IPM—differs greatly from conventional automated materials processing. In conventional practice, only the process variables—temperature, pressure—are automatically controlled to preset values which, nevertheless, still allow the microstructure and properties to deviate significantly from desired values. A critical feature of IPM is the shift from off-line measurements on finished products to on-line measurements in real-time to control processing.

Since 1987, NIST has successfully engaged in exploratory IPM programs in advanced materials, notably in the areas of powder metal atomization and consolidation. This NIST experience in intelligence processing of advanced materials is now being applied to advanced processing in the steel and aluminum industries. In 1989, NIST was invited to participate in an AISI-organized forum to identify the long-range research opportunities for the steel industry. Among other actions at this meeting, a decision was made to organize an industry-led workshop to highlight the recent advances in sensing, modeling, and process control, to identify areas of need in the primary metals industry and the role of intelligent processing of materials to solve these needs, and to develop a strategy for implementation of research results.

Planning for the workshop was initiated through a steering committee that I chaired, with representatives from steel, aluminum, and copper trade associations, individual companies, the academic community, and Federal agencies. The workshop, sponsored by NIST, the Department of Energy, and AISI, was held in August 1989. Industry, university, and Government participants reviewed information provided by researchers and operating staff from industry and developed a plan for coupling the advancing state of materials processing in the primary metals industries.

The report of the workshop summarized a research agenda for the intelligent processing of steel by defining the key elements producers need, assessing the status of available technologies, and outlining strategies for implementing their use.

The steel industry has already acted on the results from the workshop. An AISI advisory committee has reviewed the findings and has recommended to the AISI that priorities be determined from the research agenda and a long-term national research program be established with an industry consensus. NIST has taken an active role in this planning process and, at the request of the AISI, has submitted four proposals for inclusion in the national research program. These proposals are currently undergoing peer review for possible joint funding by AISI and DOE.

In fiscal year 1991, NIST received budget initiative funding of $900,000 to expand upon our early efforts in intelligent processing of materials and to broaden our programs in collaboration with industry. As the central focus of this initiative, a number of projects were started in December 1990 in support of intelligent processing of steel. These projects include developing sensors for texture, liquid-solid interface position, grain size, and yield strength in steel during processing, and research on the scientific basis for process models. These projects are directly related to AISI plans and needs and are focused on providing part of the generic scientific basis needed for intelligent processing of steel.

In conclusion, the ability of NIST to continue to make significant contributions to the measurement needs of industry results from two key factors: one, the involvement of industry from the earliest planning stages of a program, through planning workshops and by having industry-sponsored research associates work hand-in-hand with NIST scientists and engineers; and two, the long-range generic laboratory research programs at NIST that compliment and support associated industrial research efforts.

That concludes my statement. I would be pleased to answer any questions the committee may have regarding the NIST role.

[The prepared statement of Dr. Schwartz follows:]

NIST
UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY

U.S. Department of Commerce
Statement of Lyle H. Schwartz
Director, Materials Science and Engineering Laboratory
National Institute of Standards and Technology
before the
Subcommittee on Environment
of the
Committee on Science, Space, and Technology
U.S. House of Representatives
April 23, 1991

Mr. Chairman, Members of the Subcommittee:

I thank you for this opportunity to describe some of the activities and accomplishments of the National Institute of Standards and Technology's Materials Science and Engineering Laboratory in support of the U.S. metals industries.

Introduction

I'd like to open my remarks by pointing out that the interaction between NIST and the steel industry is one of long standing, based on generic research at NIST closely coupled to the current needs of the industry. For more than 80 years, the National Institute of Standards and Technology has been working with the steel industry to improve the durability and performance of metals and alloys. At the turn of the century the nation was plagued with railroad accidents due to faulty maintenance, inferior iron and steel products, and severe service requirements on equipment and track. With the cooperation of steel manufacturers, NIST (then the National Bureau of Standards) undertook materials investigations on railroad iron and steel. Increased understanding of the properties of steel led to better steels, and as better steels brought about by improved technology went into rails and rolling stock, the accident rate fell by two-thirds between 1920 and 1930.

Throughout NIST's history, as in this steel effort, cooperative activities with industry have been carried out with costs co-shared by NIST and the industrial participant. In these formal cooperative agreements between NIST and industrial organizations, the industry investment has been in the form of dollars, equipment and materials, or scientific personnel characterized by NIST as Industrial Research Associates. Over 400 organizations and more than 1,000 individuals have participated in the NIST Research Associate Program since its establishment in 1920 by Samuel Stratton, the first director of NBS. The collaboration made possible by this Program has resulted in advances in fundamental knowledge and the development of measurement techniques now in widespread industrial use. The cooperative activities with industry assure rapid transfer of technical output and provide NIST managers with information on industry's needs for measurement science and data.

I would like to briefly mention several of these current cooperative activities that have broad impact on the metals industries.

Steel Related Programs

- ASM International, one of the largest technical societies in the U.S., and NIST have just completed a successful 10-year, $10 million program to compile and assess the quality of information on the phase diagrams of metals. Phase diagrams are "road maps" containing vital information about what can happen when two or more metals are mixed to form an alloy, and are used to develop new materials and design products. NIST was responsible for providing quality control and technical guidance to more than 50 technical experts world-wide. ASM raised $4 million from industry to support the program. On March 26, 1991, officials from ASM presented to Dr. John Lyons, NIST Director, copies of the new second edition of *Binary Alloy Phase Diagrams* containing more than 3,000 alloy phase diagrams.

- In 1982 the National Association of Corrosion Engineers (NACE) and NIST established a cooperative corrosion data program to help reduce corrosion damage to the nation's infrastructure--its bridges, buildings, industrial plants, vehicles, and utilities. The Corrosion Data Center serves as a focal point for addressing the complex issues in gathering and dissemination of evaluated corrosion data with industry financial support and research associates. The Center has developed user friendly personal computer programs to facilitate widespread distribution of evaluated corrosion performance and control data for engineering materials exposed to a wide range of industrial environments. To date, almost 1,000 Corrosion Data Center outputs on materials selection and control of corrosion have been sold by NACE.

Modernization of Steel Processing

As the domestic steel industry re-capitalizes, it seeks advanced technological, cost efficient, environmentally sound methods of processing steel to maintain competitiveness into the next century. In response to this need, Federal laboratories, including NIST, have worked with industry through the American Iron and Steel Institute (AISI) to formulate a plan to increase cooperation between government laboratories and industry.

Since the early 1980s, NIST has been collaborating with the steel industry to develop process control sensors to improve productivity and product quality. In 1980/81, the AISI conducted a study of sensor applications throughout the steelmaking process and identified more than 500 process control sensor needs. Top priority was given to four specific sensor needs, and in 1982, the AISI and NIST convened a workshop on process control sensors to develop the research agenda in these four areas. In 1983, NIST and the AISI established a joint research program for development of two of these sensors, one for porosity detection and the other for measurement of temperature distribution. The research, conducted mainly in NIST laboratories, involved close day-to-day collaboration between NIST scientists and staff from the steel industry assigned to NIST and supported by the AISI.

Porosity or other internal defects must be detected and cut out of steel ingots during processing to avoid failure of the finished material in use. Traditional detection methods are crude and not automated, resulting in wasted time, failure to detect all voids and pores, and wastage of steel improperly identified as flawed. The NIST/AISI program developed broadly applicable measurement methods for the rapid, on-line detection of porosity in steel. NIST collaborated with AISI member companies, Argonne National Laboratory, and commercial instrument manufacturers. In 1987, this porosity detection system received an award from Industrial Research magazine as one of the 100 most significant technical products of the year, and the system is now commercially available.

The monitoring of temperature distributions within steel strands during production is critical in continuous casting. Similarly, producers need to control temperature distribution before, during, and after reheating steel billets in certain production processes. Proper temperature control is necessary to insure that final materials properties will be uniform for the entire casting and will meet the increasingly rigid requirements of American industry. The challenge was to develop a non-intrusive sensor to measure the internal temperature distribution in hot metal. NIST and AISI member company researchers working with Pacific Northwest Laboratories and sensor vendor companies have developed an integrated temperature measurement system based on ultrasonic and laser techniques that can rapidly determine internal temperature distributions from a small number of measurements. The measurement system has successfully passed field trials in a steel mill environment, and has directly led to a research spin-off to new sensor technology for the aluminum industry.

Approximately one-fifth of U.S. aluminum production is extruded shapes, bars, pipe, and rods. Improved temperature control at the extrusion press will allow manufacturers to increase production speed of extruded materials, prevent surface cracking, and improve product yield. A cooperative research program was established in 1986 between NIST and the Aluminum Association to develop a process control sensor to measure the internal temperature of extruded aluminum as it exits the die. This eddy current-based process control sensor was developed by NIST scientists and an Aluminum Association-sponsored research associate and the laboratory prototype system successfully performed on an extrusion press in a working mill. This method is currently being extended to measure internal temperatures in complex shapes such as I-beams and channels.

Building on the existing collaborative efforts with the steel industry, NIST in 1986 expanded its program beyond sensor development. Current focus is directed toward:

- Sensor Development
    - location of solid/liquid interface
    - measurement of metal formability
- Data and Measurement Techniques for Processing
    - solidification modeling for near-net shape casting
    - modeling of thermomechanical processing
- Data for Metals Refining and Characterization
    - high temperature chemistry of refractory/slag/steel reactions
    - quantitative metallography of steel structures

Looking to the future, NIST continues to interact with the metals industry through research planning activities, and updates the technical content of the NIST program to reflect changes in research needs. Advanced manufacturing techniques increasingly demand materials of greater reliability and uniformity at competitive cost. Specific demands for properties and performance can be met by control of the processing of the materials from synthesis or raw material production to forming/finishing. Such process control, or *intelligent processing of materials (IPM)* differs greatly from conventional automated materials processing. In conventional practice, only the process variables (temperature, pressure) are automatically controlled to pre-set values which, nevertheless, still allow the microstructure and properties to deviate significantly from desired values. A critical feature of IPM is the shift from off-line measurements on finished products to on-line measurements in real-time to control processing.

The National Institute of Standards and Technology has over the past several years played a leading role in developing the concept of intelligent processing of materials and fostering the adoption of this advanced manufacturing approach by American industry. Intelligent processing of materials integrates on-line sensing of materials characteristics as they evolve during processing, mathematical process models, and expert control systems. Intelligent processing provides higher quality products, reduced rejects, faster prototyping of new materials and processes, and substantially reduced time to introduce new materials.

By the mid-1980s, the need for real-time process controls to enhance the quality of rapidly solidified metal powders and the need for additional research on automation of metal powder production had been pointed out in several studies by the National Materials Advisory Board and a workshop sponsored by the National Academy of Sciences. These advanced materials have potential applications in gas turbine components, airframe structures, and advanced magnetic materials. NIST proposed organizing a consortium to plan, financially support, and carry out cooperative research and development for automated processing of rapidly solidified metal powders. NIST was well positioned to take the lead because of its recognized strength in rapid solidification technology, the development and construction of a supersonic inert gas metal atomization facility, and the presence in other NIST units of needed expertise in fluid dynamics, particle size measurement, and automated control systems. In 1987, three industrial companies joined NIST in a three-year research effort to develop an intelligent process control system that would be applicable to a broad range of metal atomization systems currently used or under development by U.S. industry. The research focused on modeling of particle formation, advanced sensing techniques for on-line particle size measurement, and development of an intelligent control system. Significant accomplishments were realized in this phase of the research and, in some cases, were transferred directly to the consortium members.

In 1990, at the close of the three-year effort, several of the consortium members proposed a continuation or Phase II consortium to develop a second generation intelligent processing system that would integrate the results from the initial three-year program into a demonstration of a robust system for on-line production control of powder particle size in the NIST atomizer. Five industrial firms, including two of the three companies from the first consortium, and the Department of Energy have committed support, and on March 1, 1991, the Phase II metal powder atomization consortium was formally initiated.

In a parallel effort, NIST has participated in a Defense Advanced Research Projects Agency (DARPA)-funded program to apply intelligent processing concepts to the hot isostatic pressing (HIP) or near-net shape forming of intermetallic alloy metal powders into bulk materials. This program coupled NIST researchers with their counterparts in U. S. companies and several universities in order to develop process sensing methods, validated process models, and new control concepts. NIST has organized several workshops for HIP equipment manufacturers and users of the HIP process for materials manufacturing to obtain input and guidance on the direction of the research program and to report on the research progress. NIST researchers have made several important contributions, including: development of an eddy current sensor that withstands the high temperatures and pressures developed during the HIP process to measure density changes during processing; and refining the densification process model so that the model successfully predicts densification and shape changes during the HIP process.

This NIST experience in intelligent processing of advanced materials is now being applied to advanced processing in the steel and aluminum industries. In 1989, NIST was invited to participate in an AISI-organized forum to identify the long-range research opportunities for the steel industry. The industry participants concluded that research opportunities could best be addressed in the context of three long-range development projects: direct production of liquid steel; near-net shape casting; and finishing and coating operations. Successful integration of these three contiguous unit operations would yield important benefits by responding to the increasing restraints on traditional batch processing, by developing new product properties to match customer needs, and by taking advantage of this era of computational plenty to control processes for increased efficiency and product quality. A decision was made to organize an industry-led workshop to highlight the recent advances in sensing, modeling, and process control, to identify areas of need in the primary metals industries and the role of intelligent processing of materials concepts in solving these needs, and to develop a strategy for implementation of research results.

Planning for the workshop was initiated through a steering committee that I chaired, with representatives from steel, aluminum, and copper trade associations, individual companies, the academic community, and Federal agencies. The workshop, sponsored by NIST, the Department of Energy (DOE), and the AISI, was held in August 1989. Industry, university, and government participants reviewed information provided by researchers and operating staff from industry and developed a plan for coupling the advancing state of materials processing in the primary metals industries. The report of the workshop summarized a research agenda for the intelligent processing of steel by defining the key elements producers need for the intelligent processing of steel, assessing the status of available technologies, and outlining strategies for implementing their use.

The steel industry has already acted on the results from the workshop. An AISI advisory committee has reviewed the findings and has recommended to the AISI that priorities be determined from the research agenda and a long-term national research program be established with an industry consensus. NIST has taken an active role in this planning process and, at the request of the AISI, has submitted four proposals for inclusion in the national research program. These proposals are currently undergoing peer review for possible joint funding by AISI and DOE. One of these proposed projects is concerned with intelligent control of steel sheet texture during processing. Sheet texture (or metal grain orientation) is vitally important in controlling the quality of the subsequent formability of sheet steel by automotive companies and other industries utilizing stamped sheet steel. The second proposed project is directed to measuring the height of molten materials in the next generation, direct steel making process. Knowing this height will be required to maintain control of very aggressive and hot chemical reactions. The third proposed project deals with the experimental validation of mathematical process models for intelligent control of the thermomechanical processing of steel sheet. This is important because of the potential to significantly reduce the number of processing stops. The final proposal is aimed at developing on-line sensing capability to measure the mechanical properties of steel sheet. Control of the mechanical properties is critical because the mechanical properties or strength of the steel directly affects product performance.

In FY 1991, NIST received budget initiative funding of $900,000 to expand upon our early efforts in intelligent processing of materials and to initiate a major program with industry in this area. As the central focus of this initiative, a number of projects were started in December 1990 in support of intelligent processing of steel. These projects include developing sensors for texture, liquid-solid interface position, grain size, and yield strength in steel during processing, and research on the scientific basis for process models. These projects are directly related to AISI plans and needs and are focused on providing part of the generic scientific basis needed for intelligent processing of steel.

In conclusion, the ability of NIST to continue to make significant contributions to the measurement needs of industry results from two key factors: one, the involvement of industry from the earliest planning stages of a program, through planning workshops and by having industry-sponsored research associates work hand-in-hand with NIST scientists and engineers; and two, the long-range generic laboratory research programs at NIST that complement and support associated industrial research efforts.

DR. LYLE H. SCHWARTZ
Director
Materials Science and Engineering
Laboratory
National Institute of Standards and
Technology

Lyle H. Schwartz was appointed Director of the Materials Science and Engineering Laboratory in October 1984. He is responsible for NIST's materials science and engineering laboratory, which has more than 350 scientists, engineers, technicians, and support personnel, and annual expenditures of approximately $50 million. The major research interests of MSEL are metals, polymers, ceramics, and composite materials. MSEL is responsible for providing the private sector and government agencies with data, measurement methods, standard reference materials, and new scientific concepts which are fundamental to the development of high performance materials and to advances in materials processing. The programs support wide generic technologies in order to foster the safe, efficient, and economical uses of materials to meet national needs.

Schwartz is a graduate of Northwestern University, Evanston, Illinois, having received his bachelor of science in engineering (1959) and doctorate (1954) in materials science. He began his teaching career at Northwestern as an assistant professor in 1964, became a professor in 1972, then director of the Northwestern University University Materials Research Center in 1979.

His experience outside of Northwestern includes undergraduate work (1956-1959) in a student cooperative program at the Argonne National Laboratory, a National Science Foundation postdoctoral fellowship (1963-1964) at the University of Paris, Orsay, and the Centre Energie Nucleaire in Saclay, France, and a visiting scientist post (1972-1973) at Bell Telephone Laboratories. Schwartz has served as a consultant to Argonne National Laboratory and industry.

Schwartz has published more than 90 papers in the areas of phase transitions in iron alloys, applications of Mossbauer spectroscopy, x-ray and neutron diffraction, characterization of catalysts, and policy issues related to materials science and engineering. He is a co-author of two textbooks on x-ray diffraction.

He serves on a number of technical committees in the materials sciences, is a member of the Board of Directors of the National Materials Property Data Network, Inc., the Versailles Project on Advanced Materials and Standards, Fellow and Chairman of Technical Divisions Board of ASM International, and is a member of TMS, American Physical Society, University Materials Council Advisory Board, and the Materials Research Society. He chaired the Panel on International Competition and Cooperation of the NRC study on Materials Science and Engineering, and was recently appointed as chairman of the intergovernmental committee on materials science and engineering, COMAT. Schwartz received the 1990 Presidential Rank Award of Meritorious Executive for outstanding government service.

Mr. **Scheuer**. Thank you very much, Dr. Schwartz.

Mr. Streb, we have had testimony in recent weeks on DOE's energy conservation program that in this Metals Initiative, which is basically R&D, there's not enough "R" and too much "D." In other words, there isn't enough research and the program is overbalanced in the field of development programs.

Can you respond to that?

Mr. **Streb**. Mr. Chairman, I believe that there is heavy emphasis on development in the so-called Metals Initiative, and I think that's appropriate, because the Metals Initiative program was designed specifically to provide support to the industry, to bring technology into the industry in order to improve productivity, to improve energy efficiency, and to improve environmental concerns.

Mr. **Scheuer**. The question is not whether you bring in development, but what kind of development. What is the state of the art? If you look abroad at your competitors in Germany and Sweden and Japan, you find that there—if my understanding is correct—at least, five or six or seven years ago, they were way ahead of us in the level of technology, in the cutting edge of technology that they were applying then. That's one of the reasons that our steel industry, as I understand it, has been rather sorely pressed.

The question is, are you just going to take the technology that is known and out there and bring it in? Or are you going to perhaps "press the edges" of new technology and develop new systems and new means to make the U.S. steel industry competitive?

Mr. **Streb**. Yes, sir, I understand the question.

Mr. **Scheuer**. That's the question. I'm not suggesting the answer. I'm asking you for the answer.

Mr. **Streb**. I believe we are "pressing the edges," as you say. Within the Metals Initiative program there are aspects which are advancing technology. For example, in the Spray Casting that I referred to before, there is a new nozzle design, a revolutionary nozzle design, which is taking place within that program which is advancing that technology. Indeed, the objectives of that program are ultimately to lead to a production system that will produce sheet steel more effectively, but in getting there we are developing new technology in the spray nozzles, which is being conducted in addition to work that is being conducted in our National Laboratories by one of the major universities in the country.

Another area within the Metals Initiative is the area of aluminum. Now, we not only have a program under the Metals Initiative which addresses the technology of Metals, but under our materials processing program within conservation, which is a broader activity, we are addressing other technology opportunities which are not yet ready to be applied and are in fact rather basic research activities. One of those—actually, two of those—relate to the aluminum industry, and one had to do with the anode and the cathode—two of the projects had to do with the anode and the cathode in aluminum making. One of those projects has now been converted into a Metals Initiative project. The other continues in doing exploratory work.

In addition to work in those areas, we are addressing areas of need in advanced refractories and other opportunities that are not yet reflected in the Metals Initiative.

Mr. SCHEUER. I omitted to introduce our colleague, Congresswoman Morella from the State of Maryland.

Do you have a statement you would like to make, Congresswoman Morella?

Mrs. MORELLA. I can wait until my line of questioning, sir.

Mr. SCHEUER. All right, if you would like to do that. We will give you some extra time.

Mrs. MORELLA. Thank you.

Mr. SCHEUER. OK.

Dr. Schwartz, what new areas of research in the steel and aluminum industry does NIST believe will be the most promising over the next several years, let us say?

Dr. SCHWARTZ. Well, I can't speak for the entire industry, but our focus, sir, has been on the introduction of this intelligent processing not only into steel, but in general——

Mr. SCHEUER. Just for the record, could you describe what "intelligent processing" means, what that phrase means?

Dr. SCHWARTZ. Yes. Current practice usually involves pre-setting controls and determining, perhaps, the temperature and the speed of movement of steel through rolling mills and external variables in general. In recent years it has become possible to actually interrogate the quality and characteristics of the material during the forming stages, and that additional information can then be incorporated into a much more sophisticated control system to ensure higher levels of quality and greater degrees of uniformity. This kind of activity has actually been stimulated very much by advances that are required in so-called "advanced materials," materials in which process variables have to be controlled extremely tightly in order to achieve the final desired goal. Now we're finding that we can apply similar technology to the more conventional consumer materials like steel and aluminum, and polymers, for that matter. By interrogating the actual characteristics of the material during the processing stage and by incorporating a degree of understanding of that process known as "process modeling" one can use modern control technology to actually make changes in the process to adjust when the system gets just slightly out of whack, and that keeps the final quality much, much tighter and under control.

NIST's role in this activity so far has been principally in development of the novel sensor technology that is required. Each new system, each new material, each new process requires the modification of the rather limited number of existing sensor technologies so that it is customized for the particular need of that process.

Mr. SCHEUER. Thank you.

Congressman Don Ritter?

Mr. RITTER. Thanks, Mr. Chairman.

First of all, Mr. Chairman, I want to thank you for bringing up a comment of a witness at our previous hearing, Dr. Mark Ross. I would like to just expand on your questioning there.

Isn't it true in, for example, the "Spray Forming," and in many of these of what Dr. Ross referred to as "development areas," there is a tremendous amount of basic science that goes into it? It's not all one or all the other; you have specific problems that go far back into the need to investigate properties of materials or structures that result from certain kinds of processing. Isn't there a real interplay between basic science and basic research, as well as the applied development side, in a project like this, or in a series of projects like these?

Mr. STREB. Well, we believe so. For that reason we have tried to design the programs so that they concentrate not just on the end goal of producing a new steelmaking process, but they also incorporate the basic science development activities which are necessary to achieve that goal.

Within Direct Steelmaking, for example, I know that there is a good deal of rather fundamental work which is proceeding at universities which are associated with that particular effort. The fact that the work is being conducted under the AISI and certain key industrial components who are members of that industry does not suggest that it is the only work which is being done. There is a great deal more that is being done by some of the peripheral subcontractors who are dealing with the more basic issues.

Mr. RITTER. Dr. Schwartz?

Dr. SCHWARTZ. Yes, I might speak to that.

We have been engaged for some time in a project that doesn't have any immediate bearing on the steel industry because it was focused on the preparation of advanced materials, primarily intended for use in the aircraft engine arena. But the technology that is used there is one of forming small metal droplets by high-pressure gas atomization. That's precisely the same process that is the precursor activity to the program that the Department of Energy is engaged in at INEL for Spray Forming. We have managed, as a result of our program on the atomization of advanced metals, to learn a substantial amount about the characteristics of that process of Spray Forming. It involves the interaction of supersonic gases with metal flow, which brought into our program extremely interesting and rather basic studies, which involved chemical engineers and fluid dynamicists and so on, and that information is now available—not only for the program that we were engaged in but, of course, for the program that the DOE will pursue and for others.

Yes, there is certainly fundamental understanding associated with advanced development in metals and materials processing.

Mr. RITTER. Great.

And, that having been said, Mr. Chairman, I just want to point out that I don't think we, in our support for the evolution of technology through our support of R&D, should be ideologically hidebound to somehow have to defend the purity of our basic research product. I think that's where the Federal government has gotten itself into a lot of trouble, where we have almost defined ideologically—and in Administrations under Republican Presidents, I might add—that which is on target and appropriate for the Federal government to be doing. If it has anything to do with industry, if it has anything to do with the private sector, if it has anything to do with the market, it is somehow persona non grata. I think we have to get rid of that, because I think it is hindering the ability of the Federal R&D economy to underpin that which provides jobs and prosperity to the American people.

Mr. SCHEUER. May I add a footnote to that?

Mr. RITTER. Yes.

Mr. SCHEUER. It is axiomatic that when an industry isn't competitive, when steel from Japan and West Germany and perhaps other places can be sold at a railroad siding in Pittsburgh cheaper than we can produce steel in Pittsburgh, then something is rotten in Denmark. And it's not a question of producing a whole new product that we hadn't envisaged before. It's a question of producing steel cheaper and more efficiently so that it can compete, and that has to be, in its nature, applied research; practical, hands-on research to produce a particular kind of steel for which there is a market more efficiently and cheaper. That's what competitiveness is all about. That's not all of what it's about; part of it is about producing new products which will find their own market, create their own market. But a lot of it, certainly, is producing the products they produce now but more competitively, of higher quality, and better priced. And that is applied research, and it is urgently needed for the steel industry and related industries. I couldn't agree with you more.

Mr. RITTER. I think the chairman is absolutely correct. The fact is that the American steel industry, through some very, very painful restructuring, some very difficult adaptations of its own processes, and its relationships with its workers, has come up remarkably in quality, such that the quality of American steel today is competitive with some of the best that is produced overseas.

I might add that, today, at that railroad siting in Pittsburgh, someone is going to do better with USX or Bethlehem products on price than they are going to do with the Japanese product.

Mr. SCHEUER. That is devoutly to be prayed for, hoped for, and achieved.

Mr. RITTER. Well, the devaluation of the dollar had something to do with it, but all of the other things—the restructuring and the "quality" movement over the decade—have also been effective.

Mr. Chairman, I would like to just——

Mr. SCHEUER. I would like to give my colleague such time as he may need. It will come out of my time because his knowledge in this area is so superior to mine that the Committee would be better served by giving him the time.

Mr. RITTER. The chairman is modest.

Mr. SCHEUER. I say that in great sincerity. I wouldn't say that about all subjects that come before this Subcommittee, but I do say it about steel.

Mr. RITTER. He wouldn't say that about global warming, would he?

Mr. SCHEUER. No, I don't think I would.

Mr. RITTER. I enjoy the very substantive intellectual interchange that I am able to have with the chairman and the other members of the Subcommittee.

I would like to just touch on this cost-share requirement. Has the 30 percent cost-share made a substantial difference in the level of commitment by the industry parties? What do you see has been the result as a function of that cost-share? Why do you believe that we should up the ante to 50 percent?

Mr. STREB. Well, I believe in cost-share fundamentally because I believe that it is a measure of commitment of the industry to the particular project and requires industry, in effect, to buy into a given project before the development work begins.

We have had no shortage of proposals—I think very good proposals—from very good teams in the history of the Metals Initiative. For that reason we think there is a possibility that the industrial cost-sharing possibly might even be a bit more than we have been asking for so far. Of course, this has the added advantage of providing additional leverage on the Federal dollars that we have available to support these activities.

Mr. **Ritter**. Do you want to comment on that, Dr. Schwartz?

Dr. **Schwartz**. Well, the NIST program as it is presently constituted does not formally require cost-sharing because we're not actually transferring any funds to industry. The programs have been carried out at NIST.

But there is a form of cost-sharing that we believe is imperative, and that's provided by the industry through the process of providing personnel to share in the activity. We found that the Industrial Research Associates who join with us in carrying out these projects bring with them not only the resources of the industry, but commitment; and in addition, of course, they become the principal source of transfer of the technology back to the industry. So from our perspective, people are the fundamental element that the industry must contribute.

Mr. **Ritter**. I want to thank the chairman for his indulgence and just close with a question that I think a lot of us probably have on our minds.

We would like to see our industries and the metals industries recoup from what was probably 30 years—40 years, almost—of neglect of the idea of processing. Manufacturing is central to the production of wealth in America. But, where do we stand with respect to the competition? You talked about "Direct Steelmaking." We have heard that the Germans, the Austrians, the Swedes, have made some very significant strides. Can we regain the high ground? Or, are we going to do the R&D for them?

What about intelligent processing? You hear so much about the Japanese capabilities in intelligent manufacturing. Are we going to just be doing R&D in this area? Do we stand sufficiently high in the rankings with the competition, that we can actually have our own game in this field?

"Direct Steelmaking" is one example, and intelligent processing is another.

Mr. **Streb**. Let me comment on Direct Steelmaking.

The project that we are supporting is proceeding very well. I believe it is taking a direction which is unlike, in some respects, the direction that has been taken by similar developments in Japan and Germany and other places in the world, that—if successful—will ultimately yield significant advantage. We are moving in a direction in which something close to steel will be produced directly. There are no byproduct gasses which must be dealt with, which is the characteristic of the competing processes.

So I believe that we may have a technological edge in that particular area.

It is important, obviously, that we not only move quickly, and hopefully successfully, with respect to the development of that technology, but that we also implement it at an appropriate point in time, which is going to require a substantial commitment by industry. So at some point industry is going to have to take the responsibility and move forward and make the investment to utilize that technology in their process.

Mr. **Ritter**. Dr. Schwartz.

Dr. **Schwartz**. Yes, I'll speak to the intelligent processing issue. I think it is fair to say that most of the activity that has been initiated in the U.S. in the last several years was stimulated by the Federal Government, and in particular, DARPA and NIST played major roles in focusing attention on the opportunities in this area. I believe now that there is an extensive response by many other agencies, by universities and others, and we have an advantage in this particular arena in that we seem to be well ahead in the area of nondestructive evaluation, which is an appropriate technology base for the development of sensors, and we clearly have a current lead in the advanced computational capabilities that are required for process modeling and, to some degree, for advanced control.

Putting all of these things together, we have the potential for a very strong leadership position. Once again, I guess the cautionary remark that Mr. Streb made has to be made here, as well: development of these systems is the first step; implementation is a critical one, and industry must, in fact, step forward to carry on the implementation.

Mr. **Ritter**. The bottom line is, do we have, in a sense, the "machine that makes the machine"-type producers? Do we have the tool producers? Do we have companies that can actually make these things competitively? Are they still around in the USA? Are they still healthy enough to implement? I just want to get at the last, bottom line on this, which is the execution and the implementation. Are we doing somebody else's R&D?

Mr. **Streb**. Well, it is interesting that you should ask this question. We had a discussion on this involving the AISI representatives just within the last week or so. Do we still have the ability to produce the machines, in effect, was the question.

It is our opinion, or the opinion of the American steel industry, that we do in fact have that ability. I think it is imperative that we bring those particular organizations, those builders of machines, into the program at an early or an appropriate point so that they also have a commitment to this particular technology and are prepared to build it at such time as it is ready to be scaled up to production size.

Mr. **Ritter**. Thank you.

I want to thank our witnesses.

Mr. Chairman, I want to thank you for your indulgence, and Mrs. Morella, for your indulgence, as well.

I yield at this point. Thank you.

Mr. **Scheuer**. Congresswoman Connie Morella?

Mrs. **Morella**. Thank you.

The indulgence was most profitable. Thank you.

Thank you, Mr. Chairman, for calling this meeting, which I do think is important. I appreciated the testimony of our first two witnesses, from DOE and from NIST. Of course, I might make note that Dr. Schwartz just happens to be a constituent, also, from Chevy Chase, Maryland.

Of course, we just celebrated Earth Day. Earth Day newspaper articles, television specials, field trips to local rivers and recycling centers, efforts to use mass transit, are all a fitting backdrop for the hearing today, as it continues on steel and aluminum research for energy conservation. We each do what we can to improve energy conservation and energy efficiency. From what you tell us, and from what we are going to be hearing from the private sector, certainly there are many worthwhile demonstration projects in the area of steel and aluminum research.

We are reviewing the progress of the Metals Initiative, the Department of Energy's Industrial Energy Conservation and Technology Research and Development Program in the steel and aluminum industries. Reauthorization of the program would allow industries to continue energy conservation research. "Direct Steelmaking," one of the Metals Initiative projects, may save 20 percent of the energy in the steelmaking process and improve air quality. Research that helps the United States save energy should be supported.

So, I find it very valuable to hear about the ongoing projects which hold promise for greater energy efficiency. And, I certainly support funding for work that will assist us in cutting down on our massive energy consumption for conservation.

[The prepared statement of Mrs. Morella follows:]

DEPARTMENT OF ENERGY'S STEEL AND ALUMINUM RESEARCH FOR ENERGY CONSERVATION
CONGRESSWOMAN CONNIE MORELLA
APRIL 23, 1991

Constance Morella

MR. CHAIRMAN, EARTH DAY NEWSPAPER ARTICLES, TELEVISION SPECIALS, FIELD TRIPS TO LOCAL RIVERS AND RECYCLING CENTERS, AND EFFORTS TO USE MASS TRANSIT ARE A FITTING BACKDROP FOR OUR HEARING TODAY ON STEEL AND ALUMINUM RESEARCH FOR ENERGY CONSERVATION. WE EACH DO WHAT WE CAN TO IMPROVE ENERGY CONSERVATION AND ENERGY EFFICIENCY, AND IT SEEMS THERE ARE SOME WORTHWHILE DEMONSTRATION PROJECTS IN THE AREA OF STEEL AND ALUMINUM RESEARCH, WHICH WE WILL HEAR ABOUT TODAY.

WE ARE REVIEWING THE PROGRESS OF THE METALS INITIATIVE, THE DEPARTMENT OF ENERGY'S INDUSTRIAL ENERGY CONSERVATION AND TECHNOLOGY RESEARCH AND DEVELOPMENT PROGRAM IN THE STEEL AND ALUMINUM INDUSTRIES. REAUTHORIZATION OF THE PROGRAM WOULD ALLOW INDUSTRIES TO CONTINUE ENERGY CONSERVATION RESEARCH. DIRECT STEELMAKING, ONE OF THE METALS INITIATIVE PROJECTS, MAY SAVE 20% OF THE ENERGY IN THE STEELMAKING PROCESS AND IMPROVE AIR QUALITY. RESEARCH THAT HELPS THE UNITED STATES SAVE ENERGY SHOULD BE SUPPORTED.

I AM INTERESTED IN HEARING ABOUT THE ONGOING PROJECTS WHICH HOLD PROMISE FOR GREATER ENERGY EFFICIENCY. I SUPPORT FUNDING FOR WORK THAT WILL ASSIST US IN CUTTING DOWN ON OUR MASSIVE ENERGY CONSUMPTION. THANK YOU, MR. CHAIRMAN, FOR SCHEDULING THIS HEARING. I LOOK FORWARD TO HEARING FROM OUR WITNESSES. A WARM WELCOME TO DR. LYLE SCHWARTZ OF NIST AND A CONSTITUENT FROM CHEVY CHASE, MARYLAND.

Mrs. **Morella**. Now, in terms of a few questions that have arisen as I read the testimony and then listened to part of it and some of the questioning, I note that you were questioned, Mr. Streb, about something in your testimony that jumped out at me, also, at the very end, where the suggestion is made that "we believe the Federal investment should be further leveraged by increasing the level of cost-sharing from 30 percent to 50 percent." I know you gave a response that you thought this kind of thing would be equitable.

But I am wondering, would you not lose some of the cooperation of the private sector by so doing, and, therefore, lose any possible benefits fiscally with that kind of significant switch in the percentage? What do you personally feel?

I guess you can't talk personally, can you? Maybe that's one of the things that has to do with this percentage increase suggestion.

Mr. **Streb**. Well, I do believe that each project moves into a phase when substantially greater cost-sharing by industry is appropriate. We are dealing with projects for the most part under the Metals Initiative, which range from research all the way through to the demonstration. Therefore I think that it is appropriate to have a very high level of industrial cost-sharing.

So, recognize that most of these projects are made up of a range of participants that range from very small companies, or perhaps universities and laboratories, through the very large companies in the country, and therefore you have a range of abilities. Combined, we believe that under certain circumstances they should be able to contribute more to the total cost of the project than 30 percent.

Mrs. **Morella**. When we look to competitiveness, so often we hear of the contrasts between how the United States Government works with its private sector, with a series of impediments to that cooperation, that other countries appear have. Do you not feel, then, particularly with small businesses, that a possibility—or maybe a probability—is that there will be less interest in involvement with the Federal Government? Do you see that as a possibility?

Mr. **Streb**. I wouldn't suggest that we apply such heavy leverage as a requirement across the board on everything that we do within the Department of Energy's research and development program activities. We do have, aside from the Metals Initiative, other programs which have more broadly defined requirements and more flexible requirements. I wouldn't impose that on everything we do.

Therefore I think that there are opportunities for Government support for small companies with innovative ideas that may be outside of the Metals Initiative.

Mrs. **Morella**. What about R&D versus the demonstration programs?

Mr. **Streb**. Well, the Metals Initiative programs involve pretty much the full spectrum, as we were discussing earlier in the hearing, from some rather basic investigative work through the demonstration of a pilot. It's all within that.

Mrs. **Morella**. It would be interesting to hear from some of the others, too, in terms of how they perceive this suggestion or recommendation that you've made.

Dr. Schwartz, I guess you said before that you really didn't want to comment on that?

Dr. SCHWARTZ. Not on this issue.

Mrs. MORELLA. Right. I would like to ask you, though, about how NIST cooperates with DOE, how DOE uses NIST in terms of involving them. I know I read here, in the testimony, about 1989 and that planning conference, how well you worked together, the workshop on intelligent processing for primary metals. But, in addition to that, could you tell us about how you work together, and whether you might suggest a better working together, since there is always better?

Mr. STREB. We have a longstanding working relationship between the National Bureau of Standards—formerly; NIST, now—and the Department of Energy in a variety of areas. Within my own program, the Office of Industrial Technology, we have worked very closely with NIST or its predecessor in the development of sensor technologies for a range of industrial process needs.

We see that same kind of relationship emerging now on the Metals Initiative in one of the new project proposals that has been made. Dr. Schwartz has mentioned the intelligent processing activity. A great deal of that is going to focus on sensor needs, and I see NIST playing an important role in that whole program. I can't tell you specifically at this point in time what that role is; perhaps Dr. Schwartz can. But the proposal prepared by AISI does anticipate NIST's participation.

Dr. SCHWARTZ. Again, I think it is perhaps a bit premature to describe specifically how we will interact on these outstanding proposals, but we anticipate that in general the format will be similar to that which existed in the earlier programs on sensors, in which AISI, NIST, and either the Argonne National Laboratory or the Pacific Northwest Laboratories were engaged in sensor development.

Very commonly, the very basic and early developmental activity is done at NIST, and then the program transfers to one of the DOE laboratories, perhaps, or at that stage a private sensor developer is brought in for moving the technology a little farther along toward actual implementation.

Quite commonly, the DOE laboratories are in a better position for large-scale pilot plant examination. That's not always true, but in some instances the laboratory scale is at NIST and then is sometimes transferred to DOE labs. But I think each program requires its own planning.

Mrs. MORELLA. Are you satisfied with that?

Mr. Chairman, may I ask just one more question?

Mr. SCHEUER. Absolutely.

Mrs. MORELLA. Great. Thank you.

Also in your testimony, Dr. Schwartz, you say, "In conclusion," etc., "the involvement of industry from the earliest planning stages of a program." You see the ability of NIST to continue to make significant contributions, and you see "two factors: one is the involvement of industry from the earliest planning stages of a program," etc., etc.

What do you suggest we do to assist you in that, to get industry more involved?

Dr. SCHWARTZ. Well, as a matter of fact, I really don't think that we need additional assistance in getting industry more involved. As the number of programs that we've engaged in has increased over the last several years, we have had no difficulty at all in bringing industry in. They have stepped forward, in fact, to identify——

Mrs. **Morella**. They do?

Dr. **Schwartz**. Yes. I think the situation has changed considerably from the position that we might have found ourselves in 10 years ago, for a variety of reasons—certainly, strong competition from abroad, and for that matter competition from within. Many industries are finding that they cannot do the R&D activities alone. They are beginning to form consortia, of course; we know of many examples of that. And they find, where the door is properly opened to them, that interaction with Federal laboratories is also opportune.

The availability of the cooperative research and development agreements—which was, of course, introduced for Government owned/Government operated laboratories some four and a half or five years ago—has opened the way towards handling the very tricky issues of intellectual property and made it much easier for us and for industry to establish agreements and to work together. So at the moment, at least, we can identify no impediment except limited resources.

Mrs. **Morella**. Well, that's very encouraging. I'm pleased to hear it.

Mr. Streb, you have also mentioned projects that have reached holding company agreements. Have there been any significant barriers to reaching these agreements, in any case?

Mr. **Streb**. We have a total of four active projects, on two of which we have concluded the negotiations and the structuring of this holding company agreement. It represented some challenges, but we were able to do that. We anticipate that we will succceed on the other two, as well. They are currently under negotiation.

Mrs. **Morella**. So, you don't need Congress to assist you in any way with those?

Mr. **Streb**. We believe it's working very well.

Mrs. **Morella**. You do beleive it's working well. I thank you.

Thank you, Mr. Chairman. Thank you for the extra amount of time.

Mr. **Scheuer**. Thank you.

Congressman Howard Wolpe from the great steel-consuming State of Michigan?

Mr. **Wolpe**. Thank you, Mr. Chairman. I'll pass.

Mr. **Scheuer**. You're going to pass? Okay.

Thank you very, much. This was a very interesting and stimulating panel. We appreciate your time.

We will now move to the next panel: Mr. William Dennis, Mr. Michael Lanyi, Mr. Temple Brown, and Mr. Egon Wolff.

All right. Why don't we go from your left to your right? We'll start off with Mr. Michael Lanyi, Manager, Technology Development, Primary Metals Group, Air Products and Chemicals, Inc., of Allentown, Pennsylvania.

Mr. **Ritter**. Mr. Chairman, if I might just introduce my constituent for a moment?

Mr. **Scheuer**. Oh, by all means.

Mr. RITTER. I want to welcome Mike to Washington and to the Subcommittee, and say that he represents, today, Air Products and Chemicals, which is one of the most forward-thinking and -looking industrial organizations in America, today. It extends globally. Its horizons are far and wide. It is expanding its employment in my district and all over America. It believes in the application of science and technology immediately in the marketplace. It competes with Japanese and Germans. And, I am very proud to have Mike representing us from Air Products.

Mr. SCHEUER. Thank you very much.

Mr. Lanyi, after that superb introduction, we expect great things from you this morning.

To repeat to the panel, we hope you will sum up your testimony in five minutes, and you can be assured your testimony will be printed in full in the record at the point at which you testify.

Please proceed, Mr. Lanyi.

STATEMENT OF MICHAEL D. LANYI, MANAGER, TECHNOLOGY DEVELOPMENT, PRIMARY METALS GROUP, AIR PRODUCTS & CHEMICALS, INC., ALLENTOWN, PA

Mr. LANYI. Thank you, Mr. Chairman, Mr. Ritter, and subcommittee members.

Representing a major supplier of industrial gasses to the metals industries, and as an industrial participant in one of DOE's steel initiative projects, I am pleased to appear before the subcommittee to discuss the Metals Initiative in general and our Spray Forming of Steel project in particular.

I have submitted my testimony for the full record and I just want to emphasize the points that I feel are important at this point.

To reiterate, the objective of this project is to take molten steel while it is still in the molten state and flow it through a unique, innovative design of atomizing nozzles that create a spray of molten metal of controlled distribution that impacts on a substrate to make strip entirely in one step. That's quite an undertaking.

Two factors, however, make this particular project promising and exciting. First is the new special design nozzles that overcome a lot of the problems that have been realized in past attempts. And second, because these nozzles create such a fine distribution of metal sprays, we have the promise of having rapid solidification technology practiced on a large scale. I would just comment on each of them.

In the past, when this project was undertaken against the background of past spray forming technology—foreign, I might add—it also was undertaken in the background of some past attempts to spray form strip directly. But the problems in the past have been too low a metal through-put, lack of control on these nozzles, too much overspray resulting in poor yields, and lack of uniformity. You could get variable properties and poor quality. So the nozzle is the crux of the problem.

The current program is based on some innovative designs that came out of our laboratory, our inventive minds—they didn't come out of industry—which addressed these problems, and the lab scale results to date have shown great promise in overcoming these difficulties.

The second factor is the ability to achieve this very rapid solidification. That's the other exciting part of this development. Because of these fine droplet sizes, we get very uniform and fine microstructures. And because of the rapid quench of these fine droplets, we get microstructures that are equivalent to those produced by the powder metallurgy route without the complication and expense of having to consolidate powders and isostatically press and heat treat—we're doing it in one step. This means that we can produce strip products with compositions that are impossible to produce by conventional means. We can force into solution alloys that otherwise wouldn't want to be there so that we can make new products. You can get properties because of the fine grain. In fact, on some plain old 10 20 carbon steel, we are seeing evidence of superplastic formability because of the very fine microstructure. And we can tolerate in this matrix impurity elements that in the past were unacceptable. But, because of their fine dispersion, things like copper that are creeping into the scrap supply are showing no problem at all. In fact, some of these that have been impurity elements have become alloying elements. That's the exciting part, that it has the potential right now to save energy and save cost, but it has the added benefit of taking you into new materials.

History is replete with examples where the ability to produce new materials by a new process actually leads to the development of new materials. We have seen that with various refining processes. That's what I think we have here.

The program history, briefly: We are at the conclusion of a two-year phase—one which did benchscale testing of three innovative nozzle approaches. Private industry participated to enable the development of these nozzles with our cost-share, but all the work was done in the laboratories. Out of that effort we have identified two of the nozzles of immediate interest to a group of participants, and the private sector now wants to propose to take these two nozzles and pilot-plant them in a phase two. We are in the process, just at the point, of submitting our proposal to the DOE.

The three main project incentives which I alluded to are energy savings, which on a nationwide basis could be as much as 1.7 quads per year—that's like 29 million barrels of oil; operating cost savings on the order of $32 per ton over the cost to traditionally cast, reheat, roll, and take steel down through the steps; and the one that is difficult to quantify, but most exciting in my perspective, is materials advancements. We can produce 6.5 percent containing electrical steels. Electrical steels are used in every transformer and motor in this country, and a lot of the energy is lost just by the core loss in transforming energy. You can put 6.5 percent silicon in a structure, and you can increase the resistivity to where you save 40 percent of the energy loss in that conversion.

We can look at strength enhancements, ductility enhancements. We will be able to produce composition gradient materials with corrosion resistance on one side by spraying one material, and high strength on the other side.

I talked about the ability to tolerate residual elements that heretofore have been very detrimental, but in the very fine microstructure, are alloying elements. This opens the possibility of reducing manganese requirements, for instance, and manganese is strategic material. We can relax our requirements, or we can make enhanced materials.

I think there are excellent prospects for technology transfer from this project. One, there was a wide range of initial interest. We had steelmakers, suppliers to the industry such as myself, and steel users interested in this program. We have picked up a few interested parties along the way. Also, this DOE-mandated holding company concept, I think, is a convenient and motivating vehicle for getting the technology out there. I'm participating in it primarily to build additional gas markets and see it commercialized. We're not going to be satisfied if just one steel company adopts it.

Also, in phase two, this pilot plant, we want to make it available to any third parties—for a fee, of course—because we want to get some payback. But that pilot plant, run by the holding company, can easily transition into a licensing, money-making venture so that both the industrial participants and the Government get paid back.

In conclusion, I think this Spray Forming of steel really fulfills the goal of the Metals Initiative. It prompted collaboration amongst our universities and our National Laboratories and the private sector. I think I've convinced you that maybe it has the potential of really enhancing U.S. competitiveness. Without this Spray Forming project, funded by the DOE, it is very likely that the foreign concerns would have actively pursued our background patents on those nozzles. There was interest, and I wouldn't have blamed the inventors for capitalizing on it that way if there wasn't the possibility of this rapid commercialization, afforded by this program, in the United States.

I think we have to do more of this. We must do something to bring our inventive minds together with our commercializers. That's where the competition across the ocean excels so well, and maybe a few examples like this in this country will get the ball rolling.

Thank you.

[The prepared statement of Mr. Lanyi follows:]

STATEMENT

OF

MICHAEL D. LANYI
MANAGER, TECHNOLOGY DEVELOPMENT
PRIMARY METALS GROUP

AIR PRODUCTS AND CHEMICALS, INC.
ALLENTOWN, PENNSYLVANIA

ON THE

"SPRAY-FORMING OF STEEL" PROJECT
"STEEL AND ALUMINUM ENERGY CONSERVATION RESEARCH PROGRAM (METALS INITIATIVE)"

OF THE

DEPARTMENT OF ENERGY

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT
SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
U.S. HOUSE OF REPRESENTATIVES

APRIL 23, 1991

Good Morning Mr. Chairman and Members of the Subcommittee.

My name is Michael D. Lanyi; I am Manager of Technology Development in the Primary Metals Group with Air Products and Chemicals, Inc. We are very pleased to appear before the Subcommittee today and to participate in this panel. I commend you, Mr. Chairman, and your fellow Subcommittee Members for their interest in these metal industry projects.

Air Products is a major supplier of industrial gases (such as oxygen, nitrogen, and hydrogen), chemicals, and energy and environmental systems. Air Products ranks 158th on the Fortune 500 list of largest U.S. industrial corporations, with sales of approximately $3 billion per year. We are headquartered in Allentown, Pennsylvania, and employ 14,000 people worldwide.

As a technology-driven company, a major supplier to the metals industries, and a supporting industrial participant in one of the DOE-funded Metals Initiative projects, Air Products is pleased to appear before the Subcommittee on Environment to discuss the Metals Initiative Program.

This statement will address the Metals Initiative Program in general, and the Spray-forming of Steel project in particular.

SPRAY-FORMING PROJECT OBJECTIVE

The objective of the spray-forming project is to develop the process technology whereby steel: a) is taken while still in the molten state, b) is flowed to a new, innovative design, atomizing nozzle, to c) make a fine, controlled distribution spray of metal droplets which d) impact on a moving, collector substrate (belt), to e) produce a steel strip in just one step. The concept is depicted in attached figure 1.

BACKGROUND

The Spray-forming of Steel project was undertaken against the background of existing (foreign) spray-forming technology (Osprey), past attempts (Nucor Steel) at spray-forming strip directly, and a number of other near-net-shape casting developmental efforts using differing approaches (e.g. flowing metal onto rollers, etc.).

Two main factors, however, make this current project both promising and exciting. First, the current project is based on using new, special design nozzle concepts (of domestic origin) that address, and should overcome, the problems encountered in past attempts at spray-forming strip. Second, because of the fineness of droplet sizes being obtained with the nozzle technology of this program, the project promises to bring the use of Rapid Solidification Technology

(RST) to a large scale. Each of these two points is described more fully below.

The problems which prevented successful application of spray-forming to strip production in the past were:

1) Too low of a metal throughout, resulting in a production rate that was too low to integrate with up-stream and down-stream operations within a typically-sized steelmill.

2) Too much gas consumed in the process of generating the metal spray, resulting in higher expense.

3) Too much overspray, resulting in low yields.

4) Lack of uniformity in the metal spray, resulting in inferior and highly variable material properties and product dimensionality.

Lack of adequate atomizing nozzle technology proved to be (and is) the crux of the problem.

The current program addresses each of these problems through the development and application of linear spray nozzle concepts. These are nozzles that span the width of the strip being sprayed, and are projected to:

1) meet the production rate requirements necessary to match the process to conventional size melts, and allow the process to integrate within existing mills.

2) produce a much more uniform, controlled, and finer distribution of sprayed droplets.

3) achieve gas-to-metal ratios that allow metal to be sprayed with one-forth as much gas as that used in the best of past efforts.

Lab-scale results have shown great promise in all these regards.

The second factor, referred to earlier, has to do with Rapid Solidification Technology (RST). Other near-net-shape strip casting efforts (including the foreign Osprey technology) can only produce conventional solidification structures. With the nozzles being developed in this program, we are able to generate very fine, metal droplet dispersions that result in extremely uniform and refined microstructures typical of RST products. However, instead of requiring expensive and multi-step powder metallurgy production procedures, the same benefits can be achieved in just one processing step. This means that we are able to spray and produce strip products with alloy compositions that are impossible to produce by traditional methods. Also, because of this highly refined microstructure, these spray-formed strip products can tolerate, without detriment, what have traditionally been unacceptable levels of impurity elements. This is accomplished by either holding the impurity elements in solution or dispersing them so finely that they do not adversely affect material properties. In fact, as a consequence of the Rapid Solidification imparted to our spray-formed materials, property enhancements have been realized almost without exception in laboratory-produced samples.

PROJECT HISTORY

The initial phase of the "Spray-forming of Steel" project commenced in March 1989 and is just now being completed. During this first phase of the project, a consortium of private companies (Table I) provided the necessary cost-share to allow two national laboratories (INEL and ORNL) and the Materials Engineering Department at M.I.T. to each pursue development and laboratory testing of their own concept for a linear nozzle. INEL developed their "Controlled Aspirating Process", M.I.T. developed an "Ultrasonic Gas Atomizing" nozzle, and ORNL pursued a "Magnetohydrodynamic" approach. In the eyes of the industrial participants, the first two efforts have resulted in nozzle developments and process understandings that are of immediate interest. Based on the progress made in Phase I of the Spray-forming project, several of the original industrial participants wish to undertake a pilot plant operation to develop a process technology package that, at the end of the pilot plant program, will be ready for commercial development. We are currently at the point of submitting the Phase II project proposal to DOE.

PROJECT INCENTIVES

There are three main benefits which support continuation of the project:

- Energy Savings
- Operating Cost Savings
- Materials Advancements

A. Energy Savings

Compared with the traditional practice of casting, reheating, and the rolling 8- to 10-inch thick slabs to a strip product, spray-forming is projected to save approximately 1.26 million Btu per ton of steel processed. Assuming 35 million tons per year of sheet, strip, and tin mill products per year would ultimately be amenable to the spray-forming process, we calculate an energy savings of 44 x 10^{12} Btu/yr directly available to the domestic steel industry. This is approximately equivalent to 7.6 million barrels of oil per year, or the output of approximately one 1,000 MW base-load power plant.

The potential energy savings from direct spray-forming of strip is estimated to be much greater still if one looks at this issue on a larger national, rather than just a steel industry, scale. If one considers all sources of "embodied" energy consumed in the production of steel, we are able to calculate an energy savings potential for the nation on the order of 170 x 10^{12} Btu/yr (or 0.17 quad) using the same assumption as previously. This translates to approximately 29 million barrels of oil per year, or the output of three 1,000 MW power plants. Beyond this, the development and introduction of a spray-forming technology would lead to important and significant energy savings in a number of other "steel product-related" ways:

1. Sprayed zinc coatings substituting for, and satisfying the rapidly growing demand for electrogalvanized steel--steel which is currently coated by a very energy-intensive process. (Savings: 15.8 x 10^{12} Btu/yr, or about 2.7 million barrels of oil per year.)

2. Spray-forming enabling the commercial production of 6-1/2% Si steel for use in (for example) transformers, which in turn, enables drastic reductions in the losses inherent in the transmission, conversion, and use of electrical energy. (Savings: 1.1 x 10^{12} Btu/yr)

3. More economical production of "high performance alloy products" thereby leading to more widespread adoption of these alloys in waste-heat recovery and high temperature applications. (Savings: Unknown, but expected to be very significant.)

4. The introduction of new, enhanced capability materials (produced by spray-forming) which lead to energy savings/conservation in waste heat recovery/high temperature applications, or additional weight reductions in the transportation industry.

The effect of the potential energy savings in each of the last three categories is cumulative from year to year. For example, an equal number of new tons of electrical steel is placed into service each year while the savings obtained from placement of energy saving materials in past years remain. Thus, the total potential energy savings rate twenty years hence from first commercialization is twenty times the given figure. [The calculations and assumptions behind these energy savings numbers are documented more fully in the Energy Savings Justification Section of the Phase II Project Proposal soon to be submitted to DOE.]

B. Operating Cost Savings

A successful spray-forming process is calculated to have a $32/ton operating cost advantage over the conventional thick-slab casting route. Compared with emerging "thin-slab casting" process technology, spray-forming has over a $7/ton operating cost advantage. These claims are based on comparative incremental operating cost data shown in Table II.

Also shown in Table II are the operating cost advantages available if "spray-coating" is used to replace traditional galvanizing processes. In the case of hot-dip galvanizing, spray-coating holds an approximate $13/ton advantage. If fine-grained zinc coatings, capable of competing with electrogalvanized coatings can be sprayed, then we stand to realize over $68/ton operating cost savings applied to the current, but rapidly increasing, 2.5 million tons of electrogalvanized product produced in the U.S. each year.

C. Materials Advancements

Perhaps the most convincing, but difficult to quantify justification for developing advanced spray-forming technology relates to the role it will play in the materials technology revolution. History is replete with examples where the ability to produce materials by a new processing technology creates new materials. Already we can foresee the economical production of 6 1/2% Si-containing electrical steels--steels that are too brittle to produce by conventional means. We can anticipate enhanced-strength materials with improved ductilities, made from lower cost feed materials, with fewer "strategic alloy" additions. Co-deposition by interacting and overlapping sprays can result in composite materials and/or composition-gradient materials. The rapid solidification imparted to the impacting metal droplets by the spray-forming process enables placement into alloying solution elements which cannot otherwise be placed there due to the segregation which occurs in conventional-route processing. Exciting new materials with unique properties should be expected.

DOE FUNDING

DOE funding for Phase I, covering the time period March '89 - March '91, totaled approximately $5.6 million. This was spent at the three research facilities as follows:

INEL	$4.3 million
MIT	.8 "
ORNL	.5 "
	$5.6 million

A total budget of approximately $37 million over 5 years is proposed by the private sector participants for Phase II: pilot plant scale-up and operation. The majority of funds ($31 million) will be used for the pilot operation, but a portion ($6 million) will be reserved for continued supporting research at various participating laboratories. Thirty percent of the budget amount will be industry cost-share, leaving $26 million to be provided by the Federal government. This requirement by fiscal year is as follows:

FY’92	$ 7 million
FY’93	12 "
FY’94	3 "
FY’95	2 "
FY’96	2 "
	$26 million

PROSPECTS FOR TECHNOLOGY TRANSFER

By Congressional mandate, Metals Initiative Program funding is only to be provided for projects showing good prospects of enhancing the ability of U.S. industry to compete internationally through transfer of the technology to other U.S. firms. The "Spray-forming of Steel" project has all these characteristics and prospects. The project has from the outset drawn interest from steel producers, steel users, and steel industry suppliers. The proposed "holding company" team will be managed by firms with widely differing, but non-conflicting aims. The DOE-mandated "holding company" concept turns out to be a convenient and motivating vehicle for carrying out technology transfer. Once established, the holding company can become the technology licensing entity, serving as the vehicle through which both the industrial participants and the government are repaid through shared licensing revenues. In the case of the spray-forming project, we anticipate that the holding company will make available (for a fee) its pilot facilities for third party involvement and testing. Thus, early and widespread (spinoff) technology transfers will be facilitated.

CONCLUDING REMARKS

The "Spray-forming of Steel" project is one that fulfills the goals set out for the Metals Initiative Program. It has prompted collaboration among academicians, researchers in national laboratories, and the private sector, in the identification and development of a technology which shows great promise for enhancing the competitiveness of one of our most basic industries. It is doubtful that this level of collaboration would ever have been realized without the catalyst of the Metals Initiative Program. Also, in the course of initiating the project, it became clear that foreign interests would actively seek to acquire the background patents to perhaps the most promising of our domestic spray nozzle technologies if the patents were to be made available. Were it not for the promise of rapid domestic commercialization in conjunction with this Metals Initiative Program, these background patents would likely have gone to foreign competitors, resulting in yet another example of technology developed here, but commercialized elsewhere. While the Federal government should not and cannot assume responsibility for counter-acting every instance where technology might be lost to foreign concerns, we must do something to bring our inventive minds together with our "commercializers" so as to facilitate technology implementation within this country. Using Spray-forming as an example, the Metals Initiative Program appears to be doing just that.

Let us build upon the early success of this program. It seems to be working.

TABLE I

SPRAY-FORMING OF STEEL PROJECT TEAM

PHASE I

R&D LABORATORIES

Idaho National Engineering Laboratory (INEL)

Oak Ridge National Laboratory (ORNL)

Massachusetts Institute of Technology (MIT)

INDUSTRIAL PARTICIPANTS

Steel Producers:	Chaparral Steel Corporation Haynes International Geneva Steel
Steel Users:	A. O. Smith Corporation Ford Motor Company
Metals Industry Suppliers:	Air Products and Chemicals, Inc. Ajax Magnethermic Vesuvius

PHASE II

SPRAY-FORMING LIMITED PARTNERSHIP*

Chaparral Steel Corporation

Air Products and Chemicals, Inc.

Haynes International

[Alcoa, A. O. Smith, Vesuvius] possibilities

*Proposing to conduct pilot plant operations

TABLE II

INCREMENTAL OPERATING COSTS ($/TON)

A. PRODUCTION OF STEEL STRIP

	PROCESSING ROUTE		
	CONVENTIONAL THICK SLAB	EMERGING THIN SLAB	SPRAY-FORMING
CASTING	28.43	20.01	17.38
REHEATING AND ROLLING	43.17	26.33	21.53
TOTAL	71.60	46.34	38.91
SPRAY-FORMING ADVANTAGE	32.69	7.43	--

B. APPLICATION OF GALVANIZING (ZINC) COATINGS

	COATING METHOD		
	HOT DIP GALVANIZE	ELECTRO-GALVANIZE	SPRAY-FORMING
	91.42	147.00	78.46
SPRAY-FORMING ADVANTAGE	12.96	68.54	--

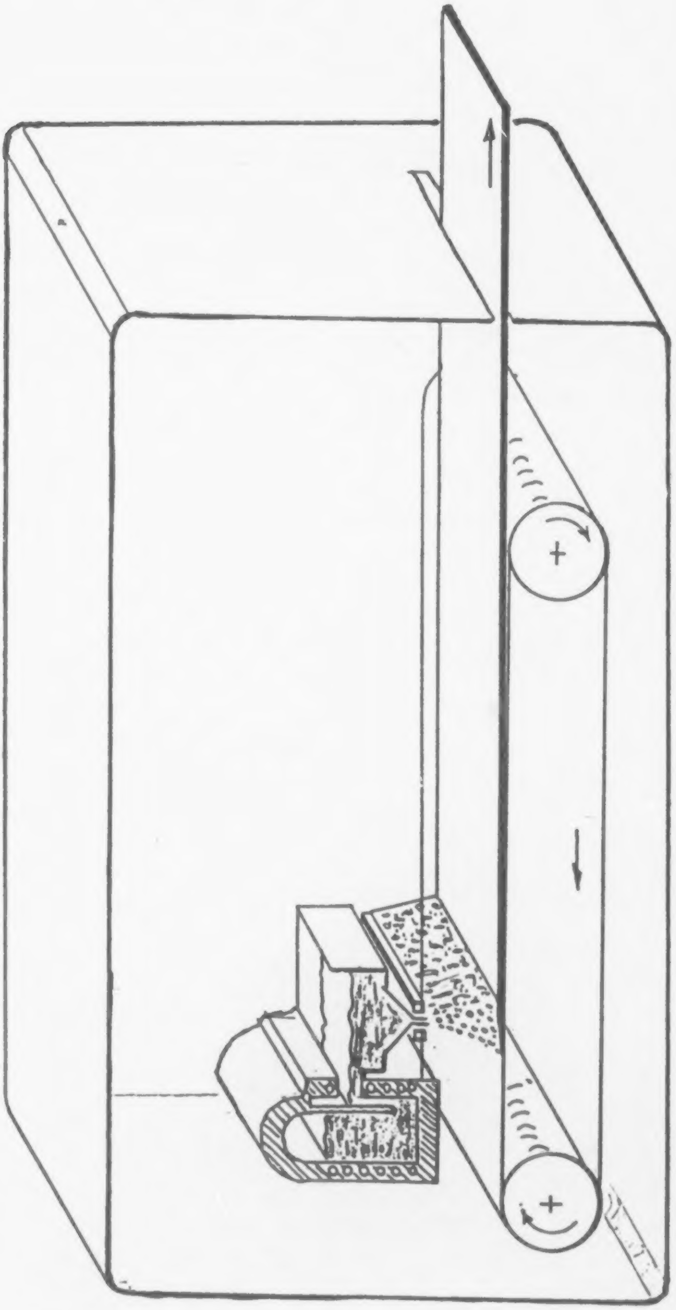

Fig. 1

Proposed Spray-Forming Process For Strip

BIOGRAPHY

MICHAEL D. LANYI

M. D. Lanyi joined Air Products' Applied Research and Development Organization in 1985. He leads the New Technology Development program involving industrial gas use in the primary metals industries. Prior to joining Air Products, Mr. Lanyi spent 9 years with Armco Steel as a Process Research Engineer in Corporate R&D, and as a Supervising Metallurgist in Armco's Specialty Steel Division. He has degrees in Metallurgical Engineering from the University of Pittsburgh (B.S.) and the University of Cincinnati (M.S.).

Mr. SCHEUER. Thank you very much, Mr. Lanyi.

It is easy to see how Air Products and Chemicals should have leapt ahead with these science and technology applications, with somebody of your quality playing an active role.

Mr. William Dennis, Vice President for Manufacturing and Technology of the American Iron and Steel Institute here in Washington.

Please proceed, Mr. Dennis.

STATEMENT OF WILLIAM E. DENNIS, VICE PRESIDENT, MANUFACTURING AND TECHNOLOGY, AMERICAN IRON & STEEL INSTITUTE, WASHINGTON, DC

Mr. DENNIS. Good morning. I am here today to represent the American and Iron and Steel Institute member companies, who produce about 80 percent of the tonnage in North America. We were involved in the Steel Initiative from the beginning, and it has brought to pass something which many of us didn't think could happen. It has got the domestic steel industry back into long-range research and development. It has created a synergism between the industry, academia, and Government which many people didn't think was possible, and I and most of my colleagues in the industry could not be more enthusiastic. We could not be more keen to see this continue.

I think between Mr. Ritter and Al Streb and the gentleman from NIST, we have heard most of the things I would have said technically, and certainly they're in my testimony. I would like to add a couple of things that came out of the discussion that took place.

Al Streb, in his summary, rather surprised me by two statements: one, that the provisions of the underlying statute remain sound and no major changes are needed; and then two sentences later he says, "Indeed, we believe Federal investment could be further leveraged by increasing the level of cost-sharing required from 30 to 50 percent."

Now, later in discussion I had the impression he was thinking of 50 percent for demonstration, and that has always seemed entirely reasonable to me. But on the high risk research of the type that we're doing on Direct Steelmaking, and the high risk research with the long reach that we're looking for in the intelligent processing, I'm absolutely convinced that the domestic steel industry would not be participating had it been 50 percent. Should the legislation be changed so that it goes from 30 to 50, I say with some certainty that the proposal on intelligent processing would be withdrawn.

The reason I am saying that is that the industry, despite the fact that it is enthusiastic, the industry at the moment is going through a blood bath of red ink which is comparable only to what we saw in 1983 and 1984.

Now, I have been surprised and delighted that despite that, there has been no indication that anyone had any interest in withdrawing from these programs. But this 30 percent cost-share does represent a very meaningful contribution. I would hate to see no cost-share. It's a means of testing our sincerity and our interest in implementing, but I think 30 percent is where it should be at the research stage. At the demonstration stage I personally would have no problem with 50 percent. I think it's very important that we all understand this.

Now, when we talk about leveraging, I'd like to point out to you that on the Direct Steelmaking project, which is going extremely well—I happened to be at the pilot plant about two weeks ago, watching the metal flowing out, an extremely smooth operation, very excited; we think we're going to get early implementation of phase one, which is with the smelter. Companies with the caliber of IBM and North American Refractories are coming in with millions of dollars worth of equipment and people and are not asking for any payment from us or from the Government. They are excited enough to get in on this project that they are bringing resources in. So we are getting significant leveraging of Government funding beyond what you see when you look at 30 percent and 70 percent.

[The prepared statement of Mr. Dennis follows:]

TESTIMONY ON BEHALF
OF THE
AMERICAN IRON AND STEEL INSTITUTE

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

APRIL 23, 1991

BY

WILLIAM E. DENNIS
VICE PRESIDENT
MANUFACTURING AND TECHNOLOGY

Testimony of William E. Dennis, Vice President, Manufacturing and Technology, American Iron and Steel Institute, Before the Committee on Science, Space and Technology, Subcommittee on Environment, U. S. House of Representatives. April 23, 1991.

I am William E. Dennis, Vice President - Manufacturing and Technology of the American Iron and Steel Institute, speaking on behalf of the 52 AISI Member Companies who account for approximately 80 percent of the raw steel produced in the United States. The purpose of appearing before you today is to provide a summary of the research and development activities that have been underway under the Department of Energy's Steel Initiative and Metals Initiative, and to encourage favorable consideration of legislation authorizing the extension of this program by not less than two years, and ideally three to five years.

The Steel Initiative was started as a result of the efforts and the leadership of the House Science, Space and Technology Committee in Fiscal Year 1986 Appropriations legislation to promote steel research and development of processes having improved energy efficiency. This program was subsequently expanded to include aluminum and other metals by Public Law 100-680, the Steel and Aluminum Energy Conservation and Industrial Competitiveness Act of 1988. One purpose of this Act is to promote public-private sector partnerships to undertake scientific research and development to develop advanced technologies utilizing the expertise of industry, university, and government laboratories' scientists.

A short while ago I presented the Howe Memorial Lecture, the most recent of a series of lectures begun in 1923 in memory of Professor Henry Marion Howe, renowned in steel research at the beginning of this century. My topic centered on lessons learned from a decade of collaborative research. I think it is a fair statement that the steel industry is now convinced of the merits of collaborative research, exactly those envisioned by the Congress when it established both the Steel and Metals Initiatives. In particular, this type of program benefits the industry by focusing the efforts of the research and development community in universities, government laboratories, and industrial laboratories.

The steel industry has generated ambitious collaborative research and development activities as a result of the Steel and Metals Initiative Programs. We have included the National Institute of Standards and Technology and the DOE National Laboratories in workshops designed to comprehensively define the industry's technological needs, bearing in mind the advanced technical prowess of these institutions. I would like to share with you some highlights of our two principal projects, Direct Steelmaking and Intelligent Processing.

Direct Steelmaking was initiated in May, 1989; the program is well underway and is making remarkable strides in the development of an energy efficient and environmentally benign technology for the production of molten steel. After nine months of highly successful operation of the Direct Steelmaking pilot plant, our research personnel have domonstrated the viability of in-bath smelting combined with a high level of post combustion, and see the opportunigy for an early commercialization of the direct ironmaking part of the process while we carry research further in the direct steelmaking part of the process. The process should be of equal interest to integrated and electric furnace producers. Smelting of ore provides virgin iron units. Additionally, the process has the flexibility of melting scrap and varying the ore-to-scrap ratio over wide ranges. This process does not require coke, thus eliminating the cokemaking operation, a major source of environmental concern. The process is closed and continuous, compared with the present process which is open and batch.

To go beyond ironmaking and produce steel directly requires a new and different approach from those being pursued by our competitors in Europe and Japan. We believe we have a viable solution with a novel smelter design involving a two-zone countercurrent smelter. Proof of concept of this direct steelmaking operation will be sought by operating the present converter process in the steelmaking mode prior to installation of the two-zone smelter during the third quarter of 1991. The engineering of the two-zone smelter is complete, and subcontracts for engineering and fabrication of the major equipment have been let. The two-zone countercurrent smelter is projected to produce hot metal with 0.5 to 1.0% carbon and 0.1 to 0.3% sulfur that will be refined to steel for continuous casting in a modified ladle station.

The steel industry has committed substantial funds in the development of a proposal on Intelligent Processing which was submitted to the Department of Energy in December for consideration under the Metals Initiative. This is a five-year, $25 million research program designed to develop and utilize process modeling, in-process sensors, and real-time computer process control. The steel industry is eager to follow the example set by the aerospace industry and DARPA in exploiting the rapidly emerging field of intelligent processing of materials. We see benefits in quality improvement, reduced inspection, increased productivity and manufacturing yield, and improved energy efficiency.

Overall, these two programs are expected to require $23 million in federal funds over the next three fiscal years. For both of these programs, the steel industry has shown its willingness to provide the required cost sharing.

Finally, we are delighted to report that the working relationship that has developed between the Department of Energy and the steel industry is exactly that envisioned by the Congress when it established [illegible] Metals Initiative. It is a true partnership involving the private and public sectors, and includes the efforts of industry, academia, and government laboratories.

Mr. **Scheuer**. Thank you very, very much, Mr. Dennis.

Now we will move to Mr. Egon Wolff, Manager of Advanced Materials Technology-Research at Caterpillar, Inc., in Peoria, Illinois.

Please proceed, Mr. Wolff.

STATEMENT OF EGON E. WOLFF, MANAGER, ADVANCED MATERIALS TECHNOLOGY-RESEARCH, CATERPILLAR, INC., PEORIA, IL

Mr. **Wolff**. Mr. Chairman, thank you.

The part of Caterpillar in this particular situation revolves around a third or fourth set of players. We are a user. We are not a steel producer or a steel manufacturer, which brings together, perhaps, a different picture to this entire project and program as it is being funded under the Metals Initiative.

The comments I would like to also state principally what my two colleagues here have voiced, one of which is, when we do have a program, maintain the program. Do not, in the middle of the course, begin to change. The importance here is that we have not learned to walk yet. To go and experiment with different relationships at this time would be very inappropriate.

Secondly, we have formed a partnership (in this particular case we're talking about the Superplastics Steel Initiative), with a National Laboratory, which for the most part to a private enterprise would be unaffordable at the levels that they are committed to charge. You must recognize that if I do research with someone, I do not need to have atomic bomb clearance. In the case of the National Lab with which we're working, that takes place. There is enormous guard and security in place. All of that adds to the cost of conducting research.

So if we are to choose a partner at a lower cost to perform research, we would not favor a National Laboratory or a source of that nature. We certainly would go on to someone else less costly.

The other point I would like to make in this particular commercialization aspect of it, it was mentioned that the cost at that particular point should be increased. Indeed, I would almost say it should be entirely borne by industry. Why should the Government be involved in commercializing a product? It does not seem to be correct. But the program (research) itself in the execution should not be changed. Once commercialization has been reached, then I would recommend that the industrial partners be made fully responsible for that task.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Wolff follows:]

TESTIMONY OF

EGON E. WOLFF

MANAGER

ADVANCED MATERIALS TECHNOLOGY RESEARCH

CATERPILLAR INC.

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

WASHINGTON, D.C.

APRIL 23, 1991

Mr. Chairman, I'm Egon Wolff, Manager, Advanced Materials Technology/Research for Caterpillar Inc. I'm pleased to appear before the Environment Subcommittee to strongly support continued funding of the Superplastic Steel project, one of four such projects conducted by the U.S. Department of Energy under the Steel and Aluminum, Energy Conservation and Technology Competitiveness Act of 1988.

Caterpillar Inc., a multinational company headquartered in Peoria, Illinois, designs, manufactures and markets earthmoving, construction and materials handling machinery and diesel and spark-ignition engines used in a variety of applications. Our products are manufactured in 36 facilities worldwide and sold through a network of over 200 dealers.

Other participants in the Superplastic Steel project include Northstar Steel Company, a Minneapolis based steel producer, Ladish Co., Inc., a Milwaukee forger, and the Lawrence Livermore Laboratory in California. This teaming effort is unique and represents a new approach in government-funded programs. Unlike most U.S. metals processing research and development programs, which have only limited market relevance, this initiative brings the primary metals producer, processor and industrial consumer together in the important areas of manufacturing and user applications.

The objective of the Metals Initiative is to develop a process for the Superplastic forming of ultrahigh carbon steel. This process will result in net or near net-shaped components, providing significant reductions in machining costs, energy to produce materials, recycling of machining chips and permitting lighter weight products.

Caterpillar and other metal users spend several billions of dollars annually on machining of steel components. We estimate that the Superplastic forming process will reduce our component processing costs by 17% and machining costs by 28% by allowing current assemblies of two or more components to be formed as one.

The main thrust of the initial project work has focused on developing a material that could be processed at high speed. The research performed by the Livermore Laboratory has substantially increased the forming rates needed for commercial viability. However, other important metal characteristics such as impact and dent resistance have not reached the same level of acceptability.

Concurrent with the Livermore Laboratory work, the industrial participants have verified the usefulness of this material for industry processing. Throughout this development there has been excellent interaction between the project's public and private participants.

The project's final two-year technology demonstration phase will focus on achieving increased impact and dent resistance in concert with a scale-up from laboratory to industrial processing. Application areas will be explored and commercial quantities of material produced for industrial prototype evaluation.

To date the total funding level for this project is $2.8 million, with Department of Energy expenditures of $2.2 million coupled with a 30%, $660,000 industry cost-share.

Mr. Chairman, the development of this high-risk, high-technology process would not have been possible without a joint public/private sector initiative. Major breakthroughs have taken place. We are well on our way to commercialization of this important manufacturing process. Our domestic steel producers, their customers and end-users will all benefit tremendously by bringing this process to the marketplace as quickly as possible.

Caterpillar Inc. and the other project participants urge the Subcommittee to authorize continued funding at a level of $2 million through fiscal year 1993 for completion of the final phase of the Superplastic Steel project.

* * *

Biography of
Egon E. Wolff

Egon E. Wolff is Manager of Advanced Materials Technology/Research for Caterpillar Inc. Caterpillar Inc., headquartered in Peoria, Illinois, is a worldwide leader in the design, manufacturing and marketing of earthmoving, construction and materials handling machinery and diesel and spark-ignition engines. Mr. Wolff is responsible for the development of new materials and standards, specifications and manufacturing practices needed for the introduction of new product technologies at Caterpillar's worldwide manufacturing operations.

Since joining Caterpillar in 1967, Mr. Wolff has held domestic and overseas management positions involving the design and processing required to manufacture large earthmoving equipment and engines.

Prior to joining Caterpillar, Mr. Wolff, a native of Germany, was employed by a German steel producer and served in the U.S. military.

Mr. Wolff, a Materials and Mechanical Engineer, serves as Chairman of the Society of Automotive Engineers' Ground Vehicle and Materials and Processing Division. He also is a member of The Illinois Coalition, a public-private sector advisory group designed to promote the development and commercialization of advanced techonology research in the State of Illinois.

Mr. SCHEUER. Thank you very much, Mr. Wolff.

And now, Mr. Temple Brown, Vice President for Corporate Research and Development of the Reynolds Metals Company.

Please proceed.

STATEMENT OF TEMPLE N. BROWN, VICE PRESIDENT, CORPORATE RESEARCH AND DEVELOPMENT, REYNOLDS METALS CO., RICHMOND, VA

Mr. BROWN. Thank you, Mr. Chairman. My presentation this morning will be condensed from the written presentation that has been submitted.

Reynolds is a fully integrated, major, global corporation with its core business in aluminum production and fabrication. I am appearing here today to offer comments on two aluminum reduction cell technologies designed to provide significant improvements in the production of metallic aluminum.

Virtually all aluminum processed today uses a 100-year-old process. This process uses large amounts of electrical power. During the 1st two decades, energy requirements for the best alumina reduction cells have decreased 22 percent, and there is potential for further power savings.

Much of the primary aluminum capacity in the United States is being replaced by offshore smelters. The average power rate in the United States is 25 mills per kilowatt hour, while power is available in other areas, in other countries, under 10 mills per kilowatt hour.

The cost of power represents about 30 percent of the total production costs of primary aluminum in the United States. Further reductions in the power requirements for aluminum production through technological improvements would be beneficial to the aluminum industry and would contribute to halting the migration of aluminum smelters overseas. There are presently 17 prebaked aluminum smelters in the United States, with a combined annual capacity of 3.5 million tons.

Reynolds, with Department of Energy support, is investigating new aluminum reduction cell technologies with the potential for significant reductions in power requirements. Work on a new cathode system, titanium diboride graphite wetted cathodes, is underway. This new cathode system replaces the existing wave prone molten metal pad with a stable cathode surface that would allow reduction of anode-cathode distance, to save approximately 1 volt per cell.

Reynolds is in the sixth month of a 38-month, $3.5 million cost-shared program under DOE's Metals Initiative that will test a system for retrofitting to existing older reduction cells. This system could reduce power usage up to 20 percent and keep the older prebaked plants more competitive. Scheduled expenditures are about $1.5 million in 1991 and $1 million in 1992, and $1 million in 1993.

Our subcontractor in this program, Great Lakes Research, has been scaling up their manufacturing process for their advanced composite material that will be used as the wetted cathode. This material has been under development and test for several years, partially supported by DOE.

Reynolds plans to have one commercial-scale reduction cell in operation by the end of 1991 and start a second cell in 1992. Each cell will be operated for one year to test and prove materials and engineering packages. This program is on schedule.

Another technology development that holds promise for reducing energy requirements for aluminum smelting is inert or non-consumable anodes. This technology offers the most potential, when combined with the wetted cathodes described previously. Together they could bring about a major change in aluminum production technology that could give an overall potential energy savings of 24 million megawatt hours per year for the U.S. industry. These anodes are further from commercialization than the wetted cathodes.

Pilot-scale anodes are scheduled for test later this year. Reynolds is a subcontractor to Battelle Pacific Northwest Laboratories and ELTECH Corporation in this program.

We believe DOE plans to continue support for an ALCOA low-temperature electrolyte program that relates to these developments. When the chemical stability of the anodes has been developed sufficiently, we would envision Metals Initiative-supported development programs to combine this anode technology with the wetted cathode technology.

There would be an environmental benefit in that this process produces oxygen gas as a byproduct, rather than carbon dioxide produced by the present process.

Reynolds Metals has supported research to reduce energy requirements and reduce emissions to the environment very willingly over the years. We are delighted to have a working relationship with the Department of Energy under the Metals Initiative established by Congress.

A holding company is being formed, as envisioned by DOE, to assure the Government that developed technologies are available for marketing to the U.S aluminum industry. The 30 percent cost-share by Reynolds and our subcontractor, Great Lakes Research, indicates a commitment to this program. We wish to thank the committee for its support and consideration for the future of the Metals Initiative. Thank you.

[The prepared statement of Mr. Brown follows:]

TESTIMONY BY TEMPLE N. BROWN

VICE PRESIDENT, CORPORATE RESEARCH AND DEVELOPMENT

REYNOLDS METALS COMPANY

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT,

HOUSE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

APRIL 23, 1991

GOOD MORNING. MY NAME IS TEMPLE BROWN AND I AM VICE PRESIDENT OF CORPORATE RESEARCH AND DEVELOPMENT FOR REYNOLDS METALS COMPANY. REYNOLDS IS A FULLY-INTEGRATED, MAJOR GLOBAL CORPORATION WITH ITS CORE BUSINESS IN ALUMINUM PRODUCTION AND FABRICATING. WE MINE BAUXITE, REFINE IT INTO ALUMINA, REDUCE THE ALUMINA INTO METALLIC ALUMINUM TO BE CAST INTO INGOT FOR FURTHER PROCESSING OR TO BE SOLD TO OTHER PROCESSORS.

I AM APPEARING HERE TODAY TO OFFER COMMENTS ON TWO NEW ALUMINUM REDUCTION CELL TECHNOLOGIES DESIGNED TO PROVIDE SIGNIFICANT IMPROVEMENTS IN THE PRODUCTION OF METALLIC ALUMINUM.

VIRTUALLY ALL PRIMARY ALUMINUM PRODUCED TODAY USES A 100-YEAR-OLD ~~TECHNOLOGY~~ PROCESS. THIS HALL-HEROULT ~~TECHNOLOGY~~ PROCESS USES LARGE AMOUNTS OF ELECTRICAL POWER AND THE HISTORY OF TECHNOLOGY DEVELOPMENT IN THE ALUMINUM INDUSTRY HAS BEEN MAINLY TO REDUCE THE AMOUNT OF POWER REQUIRED TO PRODUCE METALLIC ALUMINUM.

DURING THE LAST TWO DECADES, ENERGY REQUIREMENTS FOR THE BEST ALUMINA REDUCTION CELLS HAVE DECREASED 22 PERCENT FROM 7.7 TO 6 KWH/LB. THERE IS POTENTIAL FOR FURTHER EVOLUTIONARY POWER SAVINGS IN THE CURRENT PROCESS AND WORK ON THIS CONTINUES.

MUCH OF THE PRIMARY ALUMINUM CAPACITY IN THE UNITED STATES IS BEING REPLACED BY OFFSHORE SMELTERS BECAUSE OF THE AVAILABILITY OF LOW-COST POWER IN CERTAIN AREAS OF THE WORLD.

NEW ALUMINUM SMELTERS LIKELY TO COME ON STREAM IN THE NEXT FIVE YEARS INCLUDE ONE IN QUEBEC, ONE IN ALGERIA, ONE IN DUBAI, TWO IN VENEZUELA, ONE IN NEW ZEALAND, ONE IN AUSTRALIA, ONE IN BRAZIL, AND ONE IN MALAYSIA. THE AVERAGE POWER RATE IN THE UNITED STATES IS ABOUT 25 MILLS PER KILOWATT HOUR, WHILE POWER IS AVAILABLE IN SOME AREAS FOR UNDER 10 MILLS PER KILOWATT HOUR.

THE COST OF POWER REPRESENTS ABOUT 30 PERCENT OF THE TOTAL PRODUCTION COST OF PRIMARY ALUMINUM IN THE UNITED STATES. THE AVERAGE POWER CONSUMPTION RATE IN U.S. PLANTS IS ABOUT 7.2 KWHR/LB. OF ALUMINUM, WHILE MODERN OVERSEAS PLANTS WILL BE NEARER A 6 KWHR/LB. LEVEL.

FURTHER REDUCTIONS IN THE POWER REQUIREMENTS FOR ALUMINUM PRODUCTION THROUGH TECHNOLOGICAL IMPROVEMENTS WOULD BE BENEFICIAL TO THE U.S. ALUMINUM INDUSTRY AND WOULD CONTRIBUTE TO HALTING THE MIGRATION OF ALUMINUM SMELTERS OVERSEAS. THERE ARE PRESENTLY 17 PREBAKED ALUMINUM SMELTERS IN THE UNITED STATES WITH A COMBINED ANNUAL CAPACITY OF 3.5 MILLION TONS.

REYNOLDS, WITH DEPARTMENT OF ENERGY SUPPORT, IS INVESTIGATING NEW ALUMINUM REDUCTION CELL TECHNOLOGIES WITH THE POTENTIAL FOR SIGNIFICANT REDUCTIONS IN POWER REQUIREMENTS. WORK ON A NEW CATHODE SYSTEM, TIB2-G WETTED CATHODES IS UNDERWAY. THIS NEW CATHODE SYSTEM REPLACES THE WAVE PRONE, MOLTEN METAL PAD WITH A STABLE CATHODE SURFACE THAT WOULD ALLOW REDUCTION OF ANODE-CATHODE DISTANCE TO SAVE BETWEEN 0.8 AND 1.2 VOLTS PER CELL.

REYNOLDS IS IN THE SIXTH MONTH OF A 38-MONTH, $3.5 MILLION, COST-SHARED PROGRAM UNDER THE DOE'S METAL INITIATIVE THAT WILL TEST A SYSTEM FOR RETROFITTING TO EXISTING OLDER REDUCTION CELLS.

THIS SYSTEM COULD REDUCE POWER USAGE BY 20 PERCENT AND KEEP THE OLDER PREBAKED PLANTS MORE COMPETITIVE WITH THE EXPANDING OFFSHORE CAPACITY. SCHEDULED EXPENDITURES ARE ABOUT \$1.5 MILLION IN 1991 AND \$1 MILLION PER YEAR FOR 1992 AND 1993, INCLUDING THE COST SHARE.

OUR SUBCONTRACTOR IN THIS PROGRAM, GREAT LAKES RESEARCH, HAS BEEN SCALING UP THEIR MANUFACTURING PROCESS FOR THEIR ADVANCED TIB2-G COMPOSITE MATERIAL THAT WILL BE USED AS THE WETTED CATHODE. THIS MATERIAL HAS BEEN UNDER DEVELOPMENT AND TEST FOR SEVERAL YEARS, PARTIALLY SUPPORTED BY DOE.

REYNOLDS PLANS TO HAVE ONE COMMERCIAL-SCALE REDUCTION CELL IN OPERATION BY THE END OF 1991 AND START A SECOND CELL IN 1992.

EACH CELL WILL BE OPERATED FOR ONE YEAR TO TEST AND PROVE MATERIALS AND ENGINEERING PACKAGES. THIS PROGRAM IS ON SCHEDULE.

COMMERCIALIZATION OF THIS WETTED-CATHODE TECHNOLOGY SHOULD PROCEED IN THE INDUSTRY WITHOUT COST-SHARING SUPPORT AFTER A SUCCESSFUL COMPLETION OF THIS CURRENT PROJECT. I EXPECT THAT LARGER-SCALE TESTING WOULD BE CONDUCTED BY THE INDUSTRY DURING 1993 TO 1995. SUCH TESTS COULD LEAD TO POTLINE AND PLANT SCALE CONVERSIONS AFTER 1996. POTENTIAL ENERGY SAVINGS FOR THE U.S. ALUMINUM INDUSTRY WOULD BE THE EQUIVALENT OF AN 1100 MEGAWATT GENERATING PLANT OPERATING AT 100 PERCENT CAPACITY.

ANOTHER TECHNOLOGY DEVELOPMENT THAT HOLDS PROMISE FOR REDUCING THE ENERGY REQUIREMENT FOR ALUMINUM SMELTING IS INERT OR NON-CONSUMABLE ANODES. THIS TECHNOLOGY OFFERS THE MOST POTENTIAL WHEN COMBINED WITH THE WETTED CATHODES DESCRIBED PREVIOUSLY. TOGETHER THEY COULD BRING ABOUT A MAJOR CHANGE IN ALUMINUM PRODUCTION TECHNOLOGY THAT COULD GIVE AN OVERALL POTENTIAL ENERGY SAVINGS OF 2.4 X 10^7 MEGAWATTS HOURS PER YEAR FOR THE U.S. ALUMINUM INDUSTRY. THESE ANODES ARE FURTHER FROM COMMERCIALIZATION THAN WETTED CATHODES.

PILOT SCALE ANODES ARE SCHEDULED FOR TEST LATER THIS YEAR. REYNOLDS IS A SUB-CONTRACTOR TO BATTELLE ~~BATELLE~~ PACIFIC NORTHWEST LABORATORIES AND ELTECH CORPORATION IN THIS PROGRAM.

WE BELIEVE DOE PLANS TO CONTINUE SUPPORT FOR AN ALCOA LOW-TEMPERATURE ELECTROLYTE PROGRAM THAT RELATES TO THESE DEVELOPMENTS. WHEN THE CHEMICAL STABILITY OF THESE ANODES HAS BEEN DEVELOPED SUFFICIENTLY, WE WOULD ENVISION METALS INITIATIVE SUPPORTED DEVELOPMENT PROGRAMS TO COMBINE THIS ANODE TECHNOLOGY WITH WETTED CATHODES.

AND, THERE WOULD BE AN ENVIRONMENTAL BENEFIT IN THAT THIS PROCESS PRODUCES OXYGEN GAS AS A BYPRODUCT, RATHER THAN THE CARBON DIOXIDE PRODUCED BY THE PRESENT PROCESS.

REYNOLDS METALS HAS SUPPORTED RESEARCH TO REDUCE ENERGY REQUIREMENTS AND REDUCE EMISSIONS TO THE ENVIRONMENT VERY WILLINGLY OVER MANY YEARS. WE ARE DELIGHTED WITH THE WORKING RELATIONSHIP WITH THE U.S. DEPARTMENT OF ENERGY UNDER THE METALS INITIATIVE ESTABLISHED BY CONGRESS.

WE ARE NOW FORMING A HOLDING COMPANY WITH GREAT LAKES RESEARCH, AS ENVISIONED BY DOE, TO ASSURE THE GOVERNMENT THAT DEVELOPED TECHNOLOGIES ARE AVAILABLE FOR MARKETING TO THE U.S. ALUMINUM INDUSTRY. THE 30 PERCENT COST-SHARE BY REYNOLDS AND OUR SUB-CONTRACTOR, GREAT LAKES RESEARCH, INDICATES A COMMITMENT TO THIS PROGRAM. WE WISH TO THANK THE COMMITTEE FOR ITS SUPPORT AND CONSIDERATION FOR THE FUTURE OF THE METALS INITIATIVE. THANK YOU.

Mr. SCHEUER. I thank you very much, Mr. Brown.

And now at this time, in recognition of my colleague's depth of knowledge and expertise in this subject, I am going to yield to him my five minutes so that he will have, in addition to his five minutes, ten minutes of questioning.

Mr. RITTER. Thanks, Mr. Chairman. I wish that were true. Once you get into politics, and you go to Congress and spend 12 years out of your field, you're just about as lost as any other attorney on the Committee.

I just want to commend the group here and point out that, with the new advanced technology program at NIST, which talks about collaboration as a new way of going about getting things done faster and bringing technology to the marketplace faster, with Dr. Bromley's comments on the acceptability now of precompetitive stage R&D, which you can define fairly widely if you want to, and with the tremendous tradition of our industrial competitors and their ability in Germany and Japan to settle things—to get over the key technological hurdles and then go on and take on the world, and each other, as a matter of fact, I think this is an excellent program. It shows that the Government can act as a stimulus to a private sector situation where we don't have the tradition of working inter-industrially, like some of our competitors do.

So, with that in mind, Mike Lanyi, you mentioned how foreign concerns could well have brought up some of the key original technology patents, nozzle patents, and that there was some kind of interest there, and that you see the need for more of these kinds of efforts.

Do you want to expand on that just a little bit? Where would we be in these fields, if we weren't doing this kind of stimulative effort?

Mr. LANYI. Well, I view it as somewhat of a vicious circle. I mean, on the one hand, the steel industry isn't a very glamorous place for young people to plan to make their career. So where do all of the Ph.D. candidates come from? There are a lot of foreign interests sending their students over to this country, educating them at our best educational facilities, and of course they take the word back. They see what's being invented. We don't have that contact with U.S industry. I think it is only right that those that are progressive want to get that latest technology and go after it.

So we need to do something to kind of break the cycle. We need to get the steel industry looking somewhat attractive as a place where young people would want to go, that kind of forges relationships with the universities. I think some of the things—for instance, the in-bath smelting that is prompted with the Center for Iron and Steelmaking Research at Carnegie-Mellon is the first time I've seen close ties, with the universities finally working in step with industry. In fact, in that example, some of the basic work that is enabling the in-bath smelting is occurring right at Carnegie-Mellon University, and it is starting to build a little momentum. There is a little bit of interest there.

Mr. RITTER. Do you feel that we could be competitive in executing that kind of technology, implementing it, bringing it to the marketplace, if we were to——

Mr. **Lanyi**. I think it is a first step to being competitive, and it is an absolute necessity to survive. We even need people to understand what's going on in the rest of the world so that we can even adopt and decide when that type of technology makes sense for us.

Mr. **Scheuer**. Will my collegue yield?

Mr. **Ritter**. I yield to the Chairman.

Mr. **Scheuer**. I think it is essential that our young people in America, the best and brightest in the universities and the Ph.D. candidates coming out of the graduate schools, be attracted to getting into manufacturing industries. We have lost interest in making things in this country. It isn't as chic, perhaps, to a young person as going down to Wall Street and getting a job with an investment banking firm, or going to work with a law firm and engaging in leveraged buy-outs, essentially shuffling paper and not producing anything.

For the benefit of our society, we have to get back to the business of making things and not just shuffling paper and engaging in sophisticated financial deals and leveraged buy-outs. These can be very profitable and lucrative to the individual, and perhaps to the firm, but from the point of view of the country, our future prosperity is going to be tied up with producing things, and being competitive in the production of goods and services that can be exported around the world.

Mr. **Ritter**. Mr. Chairman, if you might yield back for just a moment?

Mr. **Scheuer**. I yield.

Mr. **Ritter**. I am listening to this, and I'm saying, "That sounds like me. Am I saying this?"

Mr. **Scheuer**. See, I'm learning something. Congress is a learning experience, and our exposure together, perhaps, has brushed off a little good on both of us, Congressman.

Anyway, what are the things you think this Committee or the Congress can do to make it more attractive for young people to go into businesses that are manufacturing things? You have all heard that our economy is shifting from manufacturing to service, and now more Americans are employed in providing services than they are in providing goods and services for export, as well as for America. That's not a good thing for our society. We are shifting from high wage jobs in industry to low wage jobs in services; flipping hamburgers is not what you would call a very "up" career, and yet there's a lot of that going on. Now, it's true that some of the services—electronic services, banking services, all kinds of information services—are useful and do add to the strength and the resilience of our economy. But surely we must encourage young people to look eagerly at the business of joining a fine company that is at the cutting edge of science and technology and that is devoted to making things.

How do we achieve that? What are the incentives that we could build into the whole length and breadth of industry that would attract the brightest and the finest of our young people coming out of the universities?

Mr. **Lanyi**. Do you want me to respond?

Mr. **Scheuer**. Please, anybody.

Mr. LANYI. Well, I think some of these examples of where we're on the cutting edge and we're doing something, such as in-bath smelting or Spray Forming and materials technology, is exactly that fuel that we need to start building kind of a rallying cry that allows us to introduce and attract talent. If all they hear is that the steel industry is dying and another plant is shutting down and we're being beat up by foreign competition, it's not a place where anybody wants to go. So maybe we're getting a little bit too theoretical here; we're down to the gut level of where we have to get some of these things moving. I think these programs are a good point.

In my particular case, there was foreign interest in those background patents for nozzles. They would have taken them, and the inventors probably would have wanted to cash in somehow on all their work. And if they don't see it in the United States, where are they going to commercialize it? It's still good for mankind, but I'd like for it to be good for mankind and good for the United States.

Mr. BROWN. Mr. Chairman, I think it starts down in the lower levels of school, from grade school on up, with everybody—industry, also—participating in letting these young people know what is out there and available for them at a much earlier age. After they get to college they pretty well have their course set, but still there's a job that needs to be done there, and I think that industry, in spending part of their research and development money with the universities and the educational centers, helps from that direction to familiarize the graduate students and the undergraduate students with what is available through industry and get them to be familiar with it, and encourage them then to participate in the direction of industry.

Mr. SCHEUER. I thank you.

I yield back to my colleague.

Mr. RITTER. Thank you, Mr. Chairman.

He raised such an interesting question. I put down five little remarks that respond to his question, because I think it's somewhat at the crux of where America goes in the 1990s and the 21st century.

How do we stimulate the manufacturing economy and promote what you all are doing, and your companies are trying to do? We all agree that we have to reduce the cost of capital to these capital-intensive industries. It's just a fact of life. We have to reduce the regulatory burden. One of the reasons the lawyers and the transaction-capable people are so powerful is because we put such a burden on top of American producers. So, if a CEO is going to stay out of jail, he'd better have some darned good lawyers and darned good financial people manipulating and moving around on his behalf.

Three, intelligent trade practices.

Four, education reform, where physics, math, chemistry, and "making things" are important, as Temple Brown said, at the lowest level in the educational scheme.

And, five, it's also a function of the media. If the print media and the TV media look upon American manufacturers and American industry as a bunch of polluters and seek to pull the wool over the eyes of the poor American citizen, prone to getting his air and his water disturbed and dirtied, then we have a real problem in the image. You can certainly hear about this from the little kids who come out of a classroom in the third grade. They don't exactly look upon American industrial giants as crown jewels of a modern technological society, as is the case in Germany and Japan. So, Mr. Chairman, that was just a sidebar to your very probing question.

I will just take one more question, if I might. Thank you, Mr. Chairman.

Egon Wolff, you mentioned something about collaboration with a National Laboratory. In your case, it's Lawrence Livermore. I didn't quite pick it up. It sounded as if you are disturbed with having to do business with the National Lab, because of security requirements. What was the point you were making? Maybe, you want to clarify it for the record.

Mr. WOLFF. Yes. Thank you. The point I was trying to make was that if our cost-share has to increase, then institutions such as National Laboratories no longer become cost-effective. They are a tremendous source of research capability for us. In the case of superplastic steel, they are the principal investigators in this work, but no industry, sir, could afford those costs if they would be truly borne and absorbed by us.

So——

Mr. RITTER. Because they have the equipment, they have the personnel, they have the existing capability?

Mr. WOLFF. No, not because of that.

Mr. RITTER. Okay.

Mr. WOLFF. Because surrounding that particular laboratory and many of our other National Laboratories are three shifts of guards, large security details that maintain things undercover. That laboratory has dual operations and functions in place, to maintain exterior capability and the tools that, in this particular case, we use. But if we had to pay for the true cost, none of us could afford that.

So the suggestion or recommendation to increase cost-sharing is really what prompted that particular remark.

Mr. RITTER. Thank you.

And thank you again, Mr. Chairman, for your indulgence.

Mr. SCHEUER. Well, thank you very much. We appreciate the excellent testimony you have given us. We are grateful for your time.

The Subcommittee hearing is suspended at the call of the Chair. Thank you so much.

[Whereupon, at 11:17 a.m., the Subcommittee adjourned, to reconvene at the call of the Chair.]

APPENDICES

energy partners

April 12, 1991

The Honorable James H. Scheuer, Chairman,
Subcommittee on Environment,
Committee on Science, Space, and Technology
U. S. House of Representatives
Suite 2320 Rayburn House Office Building
Washington, D. C. 20515

Dear Chairman Scheuer,

Thank you for allowing me to testify on April 9, 1991 before your Subcommittee on Environment. We appreciate the efforts of you and your committee members to move America forward to a renewable energy future that is "friendly" to the Earth's environment. We at Energy Partners support that objective fully.

As time ran out, I felt an incomplete response was made to your question of how we can progress renewable energy technologies when gasoline is so inexpensive (about $1.50 per gallon) and available in the United States. The answer, of course, is complex.

The prices we pay for fossil fuels at either the gas pump or from a fuel oil supply company are but small percentages of the full and final "burdened" costs we in the U. S. ultimately pay. One of your committee members spoke of the large R & D costs annually in the budget for fossil fuels. The annual number for combined tax and research subsidies for these fuels is $26 billion. We also spend significant amounts for studying and trying to solve the problems caused by our addictive use of fossil fuels on both the environment and the people that habitate that environment. There are many scientists that believe the global warming damages already done may not be reversible. Who will pay for the energy to provide the additional cooling to overcome these effects? Will we use more fossil fuels for this energy need and create a never ending spiral?

We know that while we are the single largest user of fossil fuels at about a third of the world's production, we are only the sixth largest producer. At $500 million per day for Desert Storm, we have a graphic example of a part of the political costs for protecting our "vital petroleum interests" in the unstable parts of the world where production abounds. This doesn't account for the $54 billion spent prior to the Gulf War to subsidize our ongoing military presence in the Persian Gulf area. There have been estimates of the real cost of petroleum in the U. S. to be above $100 per barrel. At the recent National Hydrogen Association show, the Deputy Director for Conservation and Renewable Energy in the Pennsylvania Energy Office put the number at $70 per barrel for the past 20 years.

At $70 per barrel, there are numerous alternative energy sources that will not be political, health, or environmental hazards. At a fraction of the subsidies in place for fossil fuels, significant progress could be made in our joint quest for a renewable energy future.

Thank you for letting me respond to this question, which we believe is key to strategic planning for renewable energy. If I or any of the staff at Energy Partners can be of further assistance, please advise.

Sincerely,

John H. Perry Jr

John H. Perry, Jr.
Chairman

jhp/j

Alternative Budget for the Department of Energy's Energy Conservation Program

FY 1992

Prepared by:

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April 1991

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ALTERNATIVE BUDGET FOR ENERGY CONSERVATION FY 1992

INTRODUCTION

In recent years, media attention on global warming, acid rain, oil dependence, and clean air have heightened the level of interest in national energy policy in general and energy efficiency in particular. Public interest in "what they can do at home" has challenged manufacturers to produce energy efficient and environmentally sound products. Electric utilities and state & local governments have invested in energy efficiency programs to reduce their need to build new power plants and to keep local dollars at home.

Despite the trend toward investments in energy efficiency, the Department of Energy's FY 1992 budget request for energy conservation makes cautious requests for increased funding. DOE recognizes the potential resource available from energy efficiency investments, but only to a point. The budget request reflects increased funding levels for research and development while proposing significantly reduced funding for technical and financial assistance programs (formerly state and local assistance programs). The DOE budget request does not acknowledge the contribution that state and local programs have made to reducing the energy burden on low-income families.

The increased funding levels proposed by the Administration for research and development should be applauded. They allow for research to continue in research areas that have been dormant or progress to continue in research areas that have been dormant or making slow gains since the early 1980's. However, Congress should note that even with a 27 percent increase in the Administration's R&D request over FY1991 funding levels, these programs have only begun the long climb to reaching peak research and development activity.

The Alternative Budget for Energy Conservation highlights the important potential from energy efficiency improvements in the major sectors of the economy. It urges Congress and the Bush Administration to expand its energy conservation budget by increasing funding for current program activities and adding funding for the new initiatives described in this document. Recommended funding levels for each major program area are shown in Table 1.

Technology transfer is an overall recommendation that is included in many of the programs and initiatives in the Alternative Budget. The Alternative Budget recommends that DOE establish joint ventures with industry, state governments and other federal agencies to move technology from the laboratory to the marketplace.

Technology transfer is emphasized in many of the specific recommendations of the Alternative Budget. Research on technology, materials or systems should be sensitive to the ultimate need to transfer the information or materials to industry.

Federal energy appropriations should be based on the potential for meeting important national needs. These include:

- Meeting energy needs economically;
- Reducing oil dependence;
- Improving U.S. international competitiveness by improving quality of goods and introducing innovative technologies;
- Improving environmental quality; and
- Improving quality of life for low-income households.

It is strongly recommended that the appropriation for DOE Energy Conservation R&D and Technical and Financial Assistance programs be increased to $778.8 million for FY 1992. The budget for R&D would be $365 million and Technical and Financial Assistance would be $423.7 million.

Table 1

FY 1992 ALTERNATIVE CONSERVATION BUDGET
DEPARTMENT OF ENERGY
(000's)

	FY 1980 Actual	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
Energy Conservation R&D				
Buildings	$98,300	$43,072	$54,187	$98,787
Transportation	$109,500	$83,846	$111,168	$127,768
Industrial	$58,300	$85,023	$101,910	$113,160
Utility	$77,800	$4,249	$6,800	$19,800
Policy and Management	N/A	$3,947	$3,600	$5,600
Subtotal-Energy Conservation R&D	$343,900	$220,137	$277,665	$365,115
Technical and Financial Assistance				
Institutional Conservation	$143,800	$31,022	$3,800	$50,000
State Energy Conservation	$37,000	$16,620	$2,200	$24,710
Energy Extension Service	$25,000	$7,500	$0	$10,290
Weatherization Assistance	$199,000	$198,952	$24,000	$300,000
Program Direction	N/A	$20,293	$5,000	$23,000
Other	$26,200	$9,629	$13,269	$15,769
Subtotal-Technical and Financial Assistance	$431,000	$284,016	$48,269	$423,769
Total-Energy Conservation	**$774,900**	**$504,153**	**$325,934**	**$788,884**

OFFICE OF BUILDING TECHNOLOGIES

The buildings sector is responsible for over 36 percent of U.S. energy consumption annually, and the current trend is for consumption levels to rise. The U.S. Department of Energy's goal for this sector is to maintain a level rate of energy consumption for the next forty years (30 quads per year) despite increases in building space. Yet, DOE's research and development funding request is 50 percent lower for buildings than for any other sector. DOE's Office of Buildings Technology cannot possibly accomplish its mission with the funding requested in the DOE budget.

There are over 90 million existing homes and new construction is over 1 million units per year. In addition, almost 75 million homes were built before 1975 when building energy standards first took effect, and most of these homes still use more energy per square foot. Residential buildings use about one-fifth of the primary energy consumed annually in the United States, and Americans pay approximately $100 billion in home energy bills for heating, cooling, refrigeration, cooking, and other conveniences. New technologies could reduce energy consumption by up to fifty percent.

There are currently 60 billion square feet of commercial building floor space; the transition to a service-oriented economy greatly expanded the amount of commercial floor space and the introduction of many new technologies increased energy uses, such as personal computers at every desk. The commercial sector accounts for more than 13 quads of the Nation's primary energy use, with about two-thirds coming from electricity use. Building owners and tenants spend about $70 billion per year for energy. Total use of primary energy for this sector have increased faster than any other since 1972.

The Alternative Budget makes two overall recommendations for the buildings sector. First, DOE should be required to develop a balanced program from research to information and technology transfer. For the past ten years policy changes and continually switching goals have lessened program effectiveness. DOE must continue to promote technical assistance, demonstration programs, and updated standards. But it must also continue to develop cost-effective new technologies that can be introduced to the building industry in reasonable cycles. Second, adequate funding must be provided for a comprehensive program. The FY 1992 DOE request only provides for a piecemeal approach.

Budget recommendations for the Buildings Sector are outlined in Table 2.

Table 2

FY 1992 ALTERNATIVE BUDGET BUILDINGS SECTOR (000's)

Activity	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
Solar Technologies	$3,530	$1,872	$7,272
Materials and Development	$5,014	$5,240	$9,440
Lighting and Appliances	$4,576	$6,950	$11,450
Heating and Cooling Equipment	$11,613	$10,680	$22,180
Indoor Air Quality	$1,592	$1,649	$4,549
Building System Research	$7,163	$12,881	$23,981
FEMP	$2,984	$4,550	$9,550
Implementation and Deployment	$1,020	$3,000	$3,000
Management	$5,580	$7,365	$7,365
Total	**$43,072**	**$54,187**	**$98,787**

BUILDINGS SECTOR - NEW INITIATIVES/EXPANDING CORE BUDGET

The following are intitiatives that will improve the Buildings Sector R&D Program (see Table 3 for a budget line item list of the initiatives).

Table 3

BUILDINGS SECTOR New Initiatives/Expanded Core (Additions to DOE Request)	
Solar Technologies Research	$2,400,000
Daylighting	$2,500,000
High Performance Envelope Integration of Solar Energy	$500,000
Windows and Glazings	$1,900,000
High Performance Building Envelope	$1,500,000
Moisture Control Strategies	$800,000
Appliance and Lighting Standards	$1,500,000
Diode Lasers for General Lighting	$3,000,000
Oil Heating Equipment	$3,000,000
Gas Heating and Cooling Equipment Technologies	$6,000,000
Joint Venture for Testing New Residential Heat Pumps	$2,500,000
Indoor Air Quality Research Program	$2,900,000
National End-Use Energy Data and Analysis Centers	$1,500,000
Outstanding Buildings Program	$800,000
Retrofit Technologies	$2,800,000
Joint Venture for Industrialized Housing	$6,000,000
FEMP	$5,000,000

Solar Technologies Research ($2.4 million)

Prior to the transfer of the Solar Technologies Program to the Office of Building Technologies, its budget was approximately $4 million per year for a program that consisted of both active and passive solar research. The current DOE request severely limits research on solar heating and cooling technologies, materials components and systems research. Additional funding is required to continue support of the solar cooling and dehumidification program, which uses desiccant materials as means to reduce the demand for mechanical cooling or air-conditioning. One-third of the funding for this program should be cost-shared with industry to begin manufacturing and demonstrating technology. The remainder of the funding should support building envelope and ventilation projects and a new initiative in perimeter thermal control systems. The former will explore several issues including economically integrating solar water heating and desiccant cooling in buildings, and longer-term issues such as using photovoltaics in buildings for direct-current appliances, ventilation and circulation of fresh air, complete electrical systems and peak load shaving.

Daylighting Research ($2.5 million)

The additional funding would expand the DOE daylighting analysis program and accelerate its electrochromic window technology research. The daylighting analysis expansion should include adequate funding to provide U.S. involvement in international measurement programs. Data from this monitoring project will help designers and the building industry maximize the benefits of solar gain when designing and siting new structures to minimize energy demand for lighting, heating, cooling, and peak energy demand. The electrochromic windows program expansion should include accelerating the development and market introduction of electrochromic windows that control daylight and solar heat gain. The accelerated program would include materials research, simulation, field testing, prototype development, and utility demonstration projects. Later phases would provide significant industry cost share.

High Performance Envelope Integration of Solar Energy Into Energy Conserving Buildings ($500,000 - 30% cost share and co-funding with state agencies and private industry)

This initiative enhances the dynamic buildings program and combines solar buildings research with conservation efforts in buildings. This project will improve our understanding of the interaction of energy conservation and passive solar inputs; and assess the relative economics of solar energy and alternatives for water heating in energy conserving buildings. It will also compare two principal methods of solar cooling, photovoltaics and heat pumps vs. thermal collectors and desiccant cooling. Finally, this project will evaluate the use of direct photovoltaic input to direct-current appliances and/or complete electrical systems for energy conservation, ventilation and circulation of fresh air, and peak load shaving.

Windows and Glazings Research ($1.9 million)

This program has been one of the most successful Buildings Sector research programs. It accelerated the development and commercialization of advanced (low-E) coatings, significantly reducing window heat loss in cold climates. These windows now account for over 25% of residential window sales and have already saved over $350 million in heating energy. The additional funding is for accelerating research on "Superwindows" (R6-10), which will make commercially available, in a few years, windows with thermal properties that equal, if not exceed, those of walls. The funding will also support development of new curtain wall systems for commercial buildings that minimize thermal and lighting energy use requirements. Finally, it will provide financial and technical support of the National Fenestration Rating Council, a national public and private sector collaboration developing an energy rating and labeling system for windows.

High Performance Building Envelopes and Perimeter Zone Systems ($1.5 million - 20% cost sharing with private industry)

This initiative includes several components: high thermal resistance "super insulations", advanced window concepts, solar perimeter control, and elements that integrate these new high energy efficiency concepts into new buildings practice. The objective is to establish DOE/industry cooperative projects to develop and demonstrate economically feasible envelope and perimeter zone control systems for residential and commercial buildings that maximize direct use of renewable energy and require no net energy for heating, cooling, and lighting in perimeter zones. This initiative would expand and integrate existing programs on new insulation technology, thermal mass, superwindows, smart window technology, solar perimeter thermal control concepts, and zero energy dynamic curtain walls.

Specifically on insulation materials, this project will enable accelerated development, prototype construction, testing and evaluation of various insulation concepts including silica aerogel, hard vacuum and powder panel approaches, multi-layer and gas-filled insulating systems.

Moisture Control Strategies ($800,000)

DOE is completing a "Moisture Handbook" and has assessed the key technical, building physics and implementation R&D needs to reduce adverse impacts of moisture in buildings.

Building envelopes can be developed with inherent moisture control capabilities without increasing building ventilation energy needs. Much of the premature deterioration in building envelopes is caused by excessive moisture accumulation. Every year millions of tons of wet insulation and roofing materials are torn off buildings and dumped in landfills. In addition, less replacement insulation is installed due to the perceived high risk of moisture damage occurring again. This program will validate envelope system moisture control strategies and wetting and drying rates controlled climate chambers. It will also develop concepts to utilize envelope materials to contribute to interior humidity control.

Appliance and Lighting Standards ($1.5 million)

The 1987 National Appliance Efficiency Act required DOE to conduct product rulemakings to implement the appliance standards required in the law. Because of insufficient funding, DOE is significantly behind schedule in the drafting of regulations that are to be issued by the end of 1992. At present, DOE has begun nine product rulemakings but, three additional major product rulemakings (furnaces, central air conditioners, and heat pumps) have not even begun. At the current rate, it will be many years before the final standards are promulgated. Yet work on appliance and lighting standards is extremely important because it directly results in energy savings. DOE needs adequate funds to ensure a thorough job and that the rulemakings get done on time. Additional funds are needed for analysis of the feasibility of standards, improving test procedures, and field surveys regarding key parameters such as level of appliance usage.

Diode Lasers for General Lighting ($3.0 million)

Diode lasers or light emitting diodes (LEDs) could have tremendous advantages over conventional incandescent or fluorescent lamps. They represent the cutting edge in lighting technology. Diode lasers have reported 75% efficiencies, which far exceeds the efficiencies of even the best fluorescent lamps (25%). Diode lasers have the potential to reduce lighting energy consumption by 50 percent and significantly reduce related cooling needs. In addition to their great potential efficiency, they are small and light weight; are not filled with toxic materials; have instant start; and operate on a safe low-voltage that uses simple wiring. DOE research helped develop compact fluorescent lamps; now it is time to move on to the next generation of efficient lighting.

Oil Heating Equipment ($3.0 million - 15% cost sharing with private industry)

Over five million oil-heated homes have been retrofitted to increase the efficiency of their oil heating equipment. Now DOE should put its research efforts into the commercial sector. The oil heating industry does not have a technical research division like the Electric Power Research Institute or the Gas Research Institute. As a result, the industry and its customers rely on federal research support.

Oil heating in commercial buildings represents 24 percent of the total energy use for space heating in commercial buildings. New technologies will reduce energy consumption in commercial oil-fired space heating systems to reduce air emissions and overall oil consumption and improve efficiency. Research will provide advanced technology in clean burning high efficiency oil-fired heating systems.

Specific projects will develop mini-oil burners for high efficiency energy-efficient small building designs; advanced venting systems designed for high efficiency systems; self-diagnostic monitoring controls; improvements in fuel oil properties; and overall systems integration. A major component of this project will be technology transfer of the results and technologies to architects, building engineers and managers in New England, the upper Mid-West and the South where oil heating equipment is most prevalent.

Gas Heating and Cooling Equipment Technologies ($6.0 million)

The Alternative Budget recommends a major increase for this area for several reasons. First, the amount of funding required for hardware development is more than that required in most other buildings sector programs. The level of engineering and issues of basic physical science are comparable to the questions facing researchers in the industrial and transportation sectors. Second, breakthroughs in heating and cooling technologies could reduce energy consumption significantly; costs, therefore, are balanced by the potential for benefits. And lastly, the natural gas industry is funding major research initiatives and this is an opportune time for the federal government to match private commitment. For example, in the fall of 1990, an industry group led by the American Gas Association, the Gas Research Institute, the Institute of Gas Technology, Southern California Gas Company, Columbia Gas System, and Brooklyn Union Gas Company recommended that the federal commitment to natural gas heating and cooling programs be increased to $18 million and the gas industry and gas equipment manufacturers will fund an equal amount for RD&D in FY 92.

The bulk of the increase would accelerate work on the second generation of absorption heat pumps. This technology is the farthest advanced of the DOE technologies and is expected to have a 40% higher cooling efficiency for residential and small commercial applications. In addition, significant funding should be provided to pursue research on the issues of materials development, mechanical engineering, and basic physics that will lead to refinements in the next generation of heat pumps using newer technologies such as triple effect and Stirling cycles.

Joint Venture for Testing New Residential Heat Pumps ($2.5 million conditioned on matching funds from industry)

This venture would initiate a two year cooperative testing program with DOE, the gas industry, manufacturers, and utilities testing the first generation of residential heat pumps that have been developed by the DOE and industry. Large scale field testing is necessary to establish that technical risks have been reduced or eliminated. Work so far has only tested ten units; before major market penetration is possible, a testing program involving 100-200 units is necessary and prudent. This is required of a complex and new technology, such as the gas heat pump, in comparison with advanced compression-type heat pump, also being researched by DOE, which would not require such a large testing protocol.

By testing more than one type of heat pump, this activity will compare competing technologies. This maximizes overall chances of success in commercializing gas heat pump technologies. This program will also provide adequate data to allow industry to make informed decisions on the desirability of individual product concepts.

Indoor Air Quality (IAQ) Research Program ($2.9 million)

The National Institute of Building Sciences' annual review of building environmental R&D, done for the National Institute for Standards and Technology, ascertained that IAQ research and development was a leading priority. Programs are underway at DOE to address this area, but have not been adequately funded to look closely at the interactions between energy-efficient building design and measures to ensure acceptable indoor environments. Modeling and field studies of IAQ in energy-efficient must be expanded to ensure health and safety. Existing buildings and weatherization of low-income housing present special problems that require significant efforts not adequately addressed in the current program.

Research tasks for an expanded budget include field studies of indoor carbon monoxide concentrations; expanding research on the effects of building factors on radon entry rates; accelerating characterization of other indoor air pollution sources such as building materials and products; developing indoor air pollution control techniques compatible with energy conservation goals; and developing ventilation designs for office buildings that can simultaneously save energy and reduce indoor air pollution levels.

Of the expanded core funds, $1.5 million will go toward a new initiative program entitled "Critical Factors for Healthy Buildings". The objective of this project is to quantitatively determine the multiple environmental and human factors that can make energy efficient office buildings healthy, comfortable, and productive work environments; to aggressively transfer this information to target audiences to improve building environments; and to increase U.S. energy efficiency, productivity and competitiveness.

National End-Use Energy Data and Analysis Centers ($1.5 million)

New energy-saving technologies are constantly being incorporated in new buildings and equipment. It is vital to maintain an up to date assessment of these innovations and to determine if their measured energy use in the field matches predictions. A federally sponsored program is necessary due to the diverse sources of measured data and the need for an impartial analysis. This information will assist utility weatherization agencies and individuals in selecting the most reliable and cost effective efficiency improvements.

Centers at the DOE regional operations offices will be established to provide "wholesale" advice to large conservation programs and projects in their respective areas. At the same time, more specialized consultation services would be available from Building Energy Technology Applications Assistance Centers located at national laboratories.

Outstanding Buildings Program ($800,000)

One of the major barriers to energy conservation is the lack of credibility of new efficiency technologies. Decision makers often do not feel sufficiently confident to distinguish technologies that work. Information exchange on building system integration is critical to furthering the implementation of outstanding technologies and designs.

This program will identify outstanding buildings and publicize them, thereby "improving the breed" by promoting selection of better designs by builders, owners, and the financial community.

Buildings will be evaluated on energy efficiency, cost, construction quality, health, comfort, aesthetics and effect on productivity. This program will be integrated with existing technology transfer programs such as CADDET, CAREIRS, NATAS, state energy offices, non-profit offices, and DOE regional offices.

Retrofit Technologies ($2.8 million)

If DOE is going to meet its goal of level sector energy consumption by the year 2030, it will have to initiate a much stronger Retrofit Technologies Program. While steps have been taken to make construction more efficient since 1975, the fact remains that millions of buildings were built prior to adoption of modern energy conservation standards and many have not been retrofitted to current standards. Conservative estimates place potential savings for retrofits at 38-42% in residential buildings and 20-25% in commercial buildings with readily available and cost-effective measures (Muller, Crenshaw Study, NIST 1982). DOE should strengthen its present program that is developing data on retrofit performance, enhanced audit procedures, and diagnostic tools and use new funding to expand technology development and transfer projects. DOE should focus on developing retrofit applications from technologies developed in its Solar, Materials and Structures, and Building Systems Programs and strengthening outreach program with HUD, state energy offices and building code commissions, utility programs, DOE's Weatherization Program, and with builder groups.

Joint Venture for Industrialized Housing ($6.0 million)

A Joint Venture initiative for industrialized housing was authorized in the Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989, P.L. 101-218, but the Administration has not requested any appropriations for this worthwhile activity. A joint venture would complement the research program on industrialized housing to accelerate the transfer of new technologies, building techniques, and other research results to the private sector. The advanced housing technology program is an excellent model of collaborative efforts between the National Association of Home Builders and DOE's national labs. DOE has surveyed members of the housing industry and should use the results of this preliminary work to design a joint venture initiative likely to receive enthusiastic support from industry. Possible joint venture activities could include improving the manufacturing and building process; advancing material, component, and whole building design and engineering; lessening institutional, economic, and regulatory barriers to adopting new technologies; evaluating unitary transport of housing; and designing and testing model homes.

Federal Energy Management Program - Enhance Core Budget ($5.0 million)

The Federal Energy Management Program (FEMP) provides leadership and guidance to federal agencies to improve the efficiency and fuel flexibility of energy use in Federal buildings, transportation and operations. The federal government spends roughly $4 billion annually on facility energy costs. Yet, FEMP has been under funded since its inception. The federal sector does not have the infrastructure nor preparation to take advantage of recent legislation regarding energy management, cost-sharing opportunities with utilities, nor the tools to implement programs. These additional funds will facilitate technical support to federal agencies to identify and acquire energy efficiency, conduct demonstrations of energy efficient technologies and practices, and develop improved acquisition procedures.

FEMP Revolving Fund (recommendation for a $500 million revolving fund)

It is recommended that a $500 million Federal Energy Management Program Revolving Fund be established to provide funding for major federal energy efficiency initiatives. The Fund would be leveraged by $500 million in matching utility funding, thus creating a $1 billion program.

Experience at over 20 representative federal installations has shown that it would be cost-effective to invest between one and two times an installation's annual energy bill in energy efficiency projects. Extrapolating to the federal sector as a whole would mean that energy efficiency investments of between $4 billion and $8 billion are cost-effective for the American taxpayer. Savings would be maximized by investing the lowest cost capital available through a systematic approach of identifying, evaluating, and implementing all cost-effective energy efficiency projects. Experience to date indicates that the majority of projects have paybacks of less than 4 years and that the technologies to be used are well established, posing no risk to the government.

The majority of the investments would be for programs greater than $10 million at large federal installations such as military bases, laboratories, hospitals, prisons, and office buildings. Given the size of the programs envisioned, the operating fund needs to approach a half billion dollars in size to have any significant effect in a reasonable period of time.

TRANSPORTATION SECTOR

The transportation sector includes passenger travel as well as commercial shipping by surface and air. This sector relies almost exclusively on petroleum for fuel. Transportation petroleum consumption was approximately 10 million barrels per day, which accounts for 63 percent of all petroleum consumed and 27 percent of all energy used in the U.S. As U.S. petroleum imports hit 50 percent, we paid approximately $50 billion in 1990 to overseas markets. With this type of fuel dependance there is an important role for the federal government to play in improving vehicle efficiency, diversifying transit modes and developing alternative fuel sources to offset increases in miles driven.

The amount of driving in this country is increasing faster than improvements in automotive fuel economy. Between 1975 and 1988 the average fuel economy of cars and light trucks improved 36.8 percent. During the same period, however, total mileage traveled by these vehicles increased 51.4 percent. Because improvements in fuel economy are not keeping pace with increases in mileage driven, total fuel consumption is increasing.

Because automobiles and trucks are replaced much more frequently than buildings, efficiency improvements enter the market more rapidly. Improvements in how we use petroleum will not only reduce the cost of transportation but reduce dollars sent abroad. Efficiency will also significantly reduce local air pollution, emissions of carbon dioxide (a global warming gas) and prevent destruction of environmentally sensitive ecosystems in pursuit of new oil sources.

The Alternative Budget supports the addition of almost $22 million for efficiency research on new ceramic materials, lubricants, hybrid electric/combustion engines, and truck engine design. Table 4 gives an overview of the Transportation Sector.

Table 4

FY 1992 ALTERNATIVE BUDGET TRANSPORTATION SECTOR (000's)

Activity	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
Alternative Fuels Utilization	$13,678	$16,000	$16,000
Materials Development	$21,686	$23,800	$28,900
Heat Engine Development	$15,817	$16,513	$19,013
Electric and Hybrid Propulsion	$25,118	$41,600	$44,600
Implementation and Deployment	$2,087	$6,500	$12,500
Management	$5,460	$6,755	$6,755
Total	**$83,846**	**$111,168**	**$127,768**

TRANSPORTATION SECTOR - NEW INITIATIVES/EXPANDING CORE BUDGETS

The following are initiatives that will improve the efficiency of the transportation sector (see Table 5 for a budget line item list of the initiatives).

Table 5

TRANSPORTATION SECTOR New Initiatives/Expanded Core (Additions to DOE Request)	
Producing Ceramic Technology	$3,000,000
Tribology	$2,100,000
Engine Optimization Using Alternative Fuels	$1,500,000
Light Vehicle Source Energy Utilization & Fuel Comparison	$1,000,000
Electric and Hybrid Propulsion Systems	$3,000,000
Automotive Gas Turbines	$4,000,000
Heavy Duty Transport	$2,000,000

Producing Ceramic Technology (\$3.0 million funding)

Although DOE has requested \$16 million for ceramic technology, only \$1 million of the \$16 million will be used for reducing the cost of producing ceramic auto components. This program will support intensive efforts to improve machining and finishings that will facilitate faster technology transfer into the marketplace and significantly reduce the cost of producing ceramic components.

Tribology (\$2.1 million)

Tribology is at present the limiting area for the design of advanced heat engines because no lubrication methods exist for the temperatures envisioned. In order to meet presently mandated emission standards, a sharp reduction in oil consumption will be required. Tribology R&D will help solve materials-related problems and accelerate the introduction of alternative, lower-emissions fuels. Given the critical nature of tribology to making efficiency gains, the \$482,000 reduction in DOE's budget request is unwarranted.

We recommend additional funding for this program in order to continue engine pollution-reduction research in lubricant chemistry and components to meet environmental protection standards. In addition, the substitution of alternative fuels for conventional fuels is expected to create significant friction and wear problems which must be overcome before widespread introduction of alternative fuels can occur.

Engine Optimization Using Alternative Fuels (\$1.5 million)

Less than six months after passage of the Clean Air Act Amendments of 1990, DOE requests a \$3 million reduction in the engine optimization program that strives to reduce air emissions and enhance combustion efficiency from alternative fuels. We applaud the addition of a demonstration project on atmospheric reactions; however, the need for basic research on engine emission controls is critical.

This project will advance the state of the art in supercomputer simulation of the chemical reactions of combustion; up to 400 exist and only 10 are well understood. It will also continue to assess advanced engine control technology for gaseous fuels, develop comparative data on conventional and reformulated petroleum-based fuels, and continue studies on tailoring diesel fuel composition to reduce emissions and enhance performance.

Light Vehicle Source Energy and Fuel Utilization Efficiency Comparison ($1.0 million)

A comparison of competing light vehicles (autos and light trucks LT 10,000 #GVW) needs to be performed to look at the source energy efficiency, fuel utilization, costs and environmental implications of competing systems. How competitive would each alternative fueling scenario be under real world conditions, competing with existing internal combustion technology? The life-cycle environmental implications of competing alternative fuel cycles need to be comprehensively reviewed, and concerns for land use, soil conservation, power plant emissions and capacity utilization, toxic wastes from greatly expanded battery production, safety of compressed natural gas and hydrogen fuel cycles must be addressed.

Consumers may purchase electric cars that recharge at night using off-peak rates. In many areas this off-peak/base-load capacity is heavily dominated by coal-fired generation which produces great quantities of CO2. How do electric vehicles and continued use of gasoline and diesel fuels really compare in terms of fuel efficiency and pollution? Other supposedly low-pollution vehicle fueling scenarios might not be as benign as anticipated when all cradle to grave fuel production, transportation, and utilization costs and efficiencies are accounted for.

Electric and Hybrid Propulsion Systems Development ($3.0 million)

The Administration has proposed a large increase in battery development for vehicles. However, the administration has proposed a decrease in systems development for electric vehicles. While R&D is critical, systems development gives the opportunity to apply electric batteries to vehicles in the near term. Some hybrid vehicles already exist But hybrid propulsion systems need to be refined and tested in actual vehicles.

This program will develop and test prototype hybrid electric vehicles (i.e., vehicles that contain both electric batteries and a relatively small internal combustion engine). These vehicles potentially offer very high efficiencies since the internal combustion engine can be operated at optimal load (some have been demonstrated at 80-115 mpg).

Automotive Gas Turbines ($4.0 million)

The Advanced Turbine Technology Application (ATTAP) expands on earlier automotive gas turbine program efforts and the companion ceramic technology for advanced heat engines project. This would develop and demonstrate the technology of structural ceramics that have potential to operate for up to 5000 hours, the standard life test, in a turbine engine environment at temperatures up to 2500 °F and have a competitive automotive engine life cycle.

Congress should continue funding research on two turbines being performed by industry contractors. This is the fifth year of a two team, five year program with activities including material assessments; engine design analysis; and component fabrication and rig tests. The technical expertise possessed by these teams, which include engine manufacturers, is a valuable asset and should be retained.

Heavy Duty Transport ($2.0 million)

Utilizing design and fabrication knowledge for ATTAP, this program will determine design and technology needs for scaling up from 100 hp to 400-500 hp gas turbines for trucking applications; the program will also design and build a prototype engine.

A second component of this program will conduct a performance and durability evaluation of a class 8 truck installed with Advanced Adiabatic Engine to assess the fuel savings and durability of the class 8 heavy duty truck operating with this engine on a test run between Indianapolis and Los Angeles.

This project will also design, build, and test a high temperature piston, Atkinson(Miller) cycle, with a coated combustion chamber for low emissions and fuel consumption.

INDUSTRIAL SECTOR

Industry accounts for about one-third of total energy use in the U.S. About 70% of this is concentrated in a handful of energy intensive manufacturing industries, including chemicals and allied products; petroleum and coal products; primary metal industries; paper and allied products; stone, clay and glass products; and food products. Studies indicate that 30-35 percent of this energy could be saved through retrofit of advanced techniques and use of better process controls.

For the past three years energy use in the industrial sector has increased and the long-term trend of decreasing energy use per unit of industrial output has begun to reverse. Energy efficiency improvements have slowed. The DOE R&D program must be strengthened and other policies pursued to reduce institutional barriers to investments in energy efficiency despite low energy prices.

The potential to improve the energy efficiency within the industrial sector is tremendous. Studies conducted by DOE show that full implementation of advanced but cost-effective energy-efficient technologies could cut industrial energy use by 27 percent, other studies up to 34 percent. Efforts must be made on the supply-side to reduce waste materials and/or transform them into higher-value products. Renewables and other alternative sources of feedstocks must be used more consistently. On the demand-side, federal leadership is needed through investments in advanced technology R&D, and supporting technology transfer from the national laboratories to industry.

The Alternative Budget makes a general recommendation that the Industrial Technologies sector adopt an overall philosophy that supports interdisciplinary research that leads to an improved understanding of the fundamental principles which drive basic industrial processes. DOE should consider starting research centers on basic industrial processes that focus on combustion, thermal sciences, materials and catalysis/biocatalysis. Table 6 outlines the budget levels for the Industrial Sector.

Table 6

FY 1992 ALTERNATIVE BUDGET
INDUSTRIAL SECTOR (000's)

Activity	FY 1991 Actual	FY 1992 Request	FY 1992 Alternative
Industrial Wastes	$4,078	$16,700	$16,700
Municipal Solid Wastes	$1,500	$6,300	$6,300
Cogeneration	$4,079	$3,264	$6,764
Materials Processing	$25,167	$20,871	$20,121
Electric Drives	$0	$500	$2,500
Separations	$5,970	$4,947	$6,947
Sensors and Controls	$2,088	$2,410	$2,410
Bioprocessing	$4,775	$5,000	$5,000
Enabling Materials	$14,324	$15,411	$18,411
Improved Combustion Efficiency	$6,740	$6,872	$8,372
Process Heating and Cooling	$6,366	$6,860	$6,860
Implementation and Deployment	$3,278	$4,800	$4,800
Management	$6,658	$7,975	$7,975
Total	**$85,023**	**$101,910**	**$113,160**

INDUSTRIAL SECTOR - NEW INITIATIVES/EXPANDING CORE BUDGETS

The following are initiatives that will improve the research programs and demonstration projects within the industrial sector (see Table 7 for a budget line item list of the initiatives).

Table 7

INDUSTRIAL SECTOR
New Initiatives/Expanded Core
(Additions to DOE Request)

Utilization of Waste Oxygen and Nitrogen Gas Streams	$1,000,000
Ceramics in Stationary Gas Turbines	$2,500,000
Enhance Core of Advanced Separation Systems	$2,000,000
Continuous Fiber Ceramic Composites	$2,250,000
Engine Combustion Process and Materials Development	$1,500,000
Planar Solid Oxide Fuel Cell Application	$2,000,000

Utilization of Waste Oxygen and Nitrogen Gas Streams ($1.0 million)

This project will investigate through a demonstration project the technical opportunities and economic feasibility of using oxygen-enriched waste streams from nitrogen supply systems in industrial cogeneration systems. This project will be run in collaboration with major gas users/suppliers.

Significant cost sharing with industry to produce a successful demonstration project. This program is important to improve U.S. competitiveness in world markets.

Improve Stationary Gas Turbine Components (\$2.5 million)

While this program is currently being funded it does not receive the funds necessary to accelerate prototype development and thereby led to a demonstration project. This project will take advantage of the recent improvements in automotive and aeronautical gas turbines from ceramic components to upgrade stationary gas turbines. It will improve the performance of continuous duty industrial gas turbines.

The project will support laboratory development of ceramic parts and testing replacement of metallic components with ceramic blades, rotors, combustor, and recuperator. Joint industry/government collaboration is critical to complete engine development and to promote introduction into the market place.

Advanced Separation Systems - Enhance Core Budget (\$2.0 million)

Expand the current program to include a wider portfolio of separation technologies that best suit industries needs. Industrial distillation and drying processes are extremely energy-intensive elements within the industrial sector.

The objectives of the project will be to develop new technologies (such as membranes, extraction, phase separation, absorption) as a replacement for many distillation, evaporation and drying processes for solids, liquids and gases. This project will also develop separation techniques to dilute process steams.

Continuous Fiber Ceramic Composites (\$2.25 million)

This program will develop a class of ceramics that combine low weight with high-temperature strength and stability in corrosive environments. Fiber ceramic composites are several times tougher than traditional, monolithic ceramics and therefore offer significant promise in improving energy efficiency and reducing environmental impacts of a wide array of industrial processes.

This program has received strong support within both DOE and Congress but is not at the funding level necessary to carry out all program components identified by DOE, suppliers and industry.

Engine Combustion Processes & Materials Development (\$1.5 million)

Increased funding for improving engine efficiency should be a national priority. Continued development of the 2-stroke engines, advanced spark-ignition engine designs, and fuel injection dynamics are critical to improving engine efficiency and reducing oil consumption.

Planar Solid Oxide Fuel Cell Application Demonstration ($2.0 million)

DOE has funded research focused on developing a technology known as the "tubular" solid oxide fuel cell (SOFC) design. The proposed "planar" SOFC design should lead to faster commercialization because of its higher performance, improved reliability, and lower cost than "tubular" designs. Applications include power generation at utilities at remote sites, industrial and commercial cogeneration, and possibly electric vehicle applications. Fuel cells efficiently convert hydrogen from natural gas into electricity. Fuel cells produce little pollution and will mitigate several environmental problems, such as emissions of CO, HC, NOx and SOx.

The objective of this initiative is to develop an efficient, reliable, and inexpensive planar solid oxide fuel cell suitable for commercial use. This is a cost shared project between DOE, the Gas Research Institute and industry.

UTILITIES SECTOR

Electricity currently supplies 36 percent of U.S. energy needs and DOE projects that growth in electrical demand is projected to continue to track growth in GNP. If this growth in electrical demand continues without gains in efficiency, increases in CO_2 and acid rain emissions would rise due to significant new power generation needs. These environmental problems can be avoided however, as the electrical sector provides a major opportunity for improvements in energy efficiency.

This section will only address those R&D efforts that are addressed in the Interior Appropriations Subcommittee (see Table 8). References to renewable technology R&D are not addressed as these programs were covered in the Alternative Budget for Renewable Energy Research & Development for FY92. In addition, the Alternative Conservation Budget does not include budget numbers for the Energy Storage Systems or Electric Energy Systems as they appeared in the Energy Supply Research and Development listing of the DOE Budget Request. We support these efforts in battery development, superconductivity, and electromagnetic field research, but have excluded them as they are not directly listed in the conservation budget.

Table 8

FY 1992 ALTERNATIVE BUDGET
UTILITIES SECTOR (000's)

Activity	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
Integrated Resource Planning	$2,984	$5,000	$11,500
District Heating and Cooling	$1,265	$1,800	$5,800
Power Generation Efficiency	N/A	N/A	$2,500
Total	**$4,249**	**$6,800**	**$19,800**

UTILITY SECTOR - NEW INITIATIVES/EXPANDING CORE BUDGETS

The following initiatives further the federal governments efforts to become a catalyst for joint ventures and industry initiatives (see Table 9 for a budget line item list of the initiatives).

Table 9

UTILITIES SECTOR New Initiatives/Expanded Core (Additions to DOE Request)	
Integrated Resource Planning	$5,000,000
Technical Assistance to "Golden Carrot" Incentives for Efficient Products	$500,000
Urban Heat Island Reduction	$1,000,000
District Heating and Cooling	$4,000,000
Existing Power Plant Improvement	$500,000
Variable Speed Drive	$500,000
Advanced Heat Rejection System	$1,500,000

Integrated Resource Planning ($5 million in additional funding):

Last year, Congress cut nearly $1 million from the Administration's $3.9 million budget request for the Integrated Resource Planning (IRP) program. This year, DOE has requested $5 million which does not keep up with the need and interest in IRP by utilities, regulators, and local governments. IRP leverages millions of dollars worth of other conservation expenditures by overcoming market barriers to investments in energy efficiency. Federal funds have helped utilities, regulators and local governments team up with DOE's national laboratories to create a national network for designing and implementing IRP strategies.

We recommend an additional $5 million above the Administration's request. These funds are needed for demand-side management activities including promotion of innovative demand-side management techniques, demand-side program monitoring and evaluation efforts, and information dissemination. This program will further promote regulatory analysis relating to financial incentives for economic utility energy efficiency investments, quantifying environmental externalities in the planning process, and providing networking and training functions to State commissions. The IRP program should also focus on promoting the application of IRP processes in the Power Marketing Administrations.

Technical Assistance to "Golden Carrot" Incentives for Efficient Products ($500,000 with cost-sharing from utilities)

Utilities and state governments have become very active in the direct or indirect purchase of ultra high-efficiency appliances. Last year, over 50 utilities met in California to address utility appliance incentive and direct purchase programs. Despite widespread interest in incentives for the purchase of efficient appliances, there is still a significant need for technical and educational assistance from those knowledgeable about appliance efficiency research and standards development to assist those purchasing and producing appliances.

Urban Heat Island Reduction ($1.0 million)

Summer temperatures in cities are typically 5-10 °F higher than those in surrounding areas. These "heat islands" are growing in size and intensity at the rate of about 1 °F per decade in some cities.

Heat island mitigation primarily requires energy efficient urban design measures. Simple as it may sound, preliminary analyses suggest that increases in tree coverage and increased surface reflection from buildings and pavements can reduce peak cooling loads in many American cities by as much as 30%. This translates into many billions of dollars of avoided investment in electric peak generating capacity, avoided bills for consumers, and avoided emissions of CO2.

Research is needed to develop inexpensive, durable surfaces that are light colored. It would be valuable to develop procedures for selecting resilient native deciduous trees and other vegetation. Monitoring and analysis are needed to document the effect of these strategies on cooling demand. Technology transfer is needed to persuade utilities and local governments of the benefits of these activities for lowering peak power demand.

District Heating and Cooling ($4.0 million)

DHC has tremendous potential to address a variety of problems, including energy efficiency, air pollution, ozone depletion, global warming and growing peak electric demand. However, this potential must be defined and quantified. A comprehensive assessment is needed of DHC's cost-effectiveness, technical performance, energy efficiency, and environmental effects compared to alternative methods for heating and cooling buildings. DHC is a relatively complex energy system and sometimes is difficult to integrate with conventional institutional processes. For these reasons, a more aggressive and comprehensive program to further DHC is needed.

This program will be divided into two components - education and technology transfer, and research. The proposed education and tech transfer program will provide both general and site-specific information to cities and electric utilities to stimulate the development of systems. Research will focus on technologies that will reduce the cost and increase efficiency of distributing thermal energy; development of heat-activated chilling technologies; advanced cogeneration DHC systems; and renewable energy DHC systems.

Power Generation Efficiency

Existing Power Plant Improvement ($500,000)

There is significant potential for energy savings and emissions reduction in existing fossil fuel plants. Efficiency improvements of 1-5% have a potential payoff of roughly 0.3 to 1.5 quads of primary energy per year in existing plants.

This program will focus on improving existing plant efficiency, and identifying new opportunities in electric plant conservation.

Variable Speed Drives ($500,000)

Fixed speed drive systems represent a large parasitic requirement for existing power plants. Use of a variable speed drive allows the power draw to fit the actual requirement and reduces vibration and large start up currents. This program will focus on market development to increase the utilization of the technology through industrial liaisons, utility market identification, and production of technology transfer material. The program will cooperate with the Electric Power Research Institute.

Advanced Heat Rejection System (\$1.5 million)

Advanced heat rejection system addresses the use of direct-contact condensers for steam power plants to improve the plant heat rate and availability. EPRI states that many existing power plants suffer an average of 3.8% loss of equivalent availability because of problems related to surface condensers. Implementation of the system is projected to result in more than 2% reduction in the cost of electricity production.

In the first year, this program will conduct a small-scale experimental verification project to develop confidence in the proposed advanced heat rejection system. The second phase will develop a prototype demonstration project. A collaboration among utilities, manufacturers of key components, national laboratories, and engineering firms will design, implement, and operate the demonstration system. Finally, the findings from the program will be made available to encourage technology transfer within the industry.

TECHNICAL AND FINANCIAL ASSISTANCE

This section supports funding recommendations for programs run by state and local governments and weatherization programs. The current Administration continues the trends started by the Reagan Administration by proposing a budget that eliminates or drastically reduces these programs. We recommend that Congress continue to support these programs as it has done for the past twelve years in the face of weak Administration budget requests.

The President's Budget proposed practically zero federal funding for Weatherization Assistance, Institutional Conservation, State Energy Conservation, and Energy Extension Services, continuing a decade-long trend of failure to support state energy efficiency efforts.

The Administration claims that the states have sufficient oil overcharge funds to implement the state and local assistance programs. Despite the Administration's claims, which Congress has never accepted, the oil overcharge refunds are a dwindling resource. As the National Consumer Law Center's last report indicated, the bulk of the oil overcharge funds, over $3 billion, were distributed in 1986 and 1987 and have already been allocated or designated. In 1990, states received about $143.5 million of principally new case settlement funds, of which a good portion is already claimed. With only one remaining oil overcharge case yet unsettled, where does the Administration expect the additional funds to come from?

In addition to relying on spent funds, the Administration ignores the legal mandate that requires oil overcharge funds to supplement existing federal and state funding, not supplant it. The administration's disregard for this stipulation means that low-income family's are more reliant on the Low-Income Heating Energy Assistance Program which pays a portion of the family's heating bill. A more long-term solution would be to weatherize their home to reduce costs and improve comfort.

Federal funding of these programs is critical to create a balanced national energy policy. Unfortunately, the Administration's National Energy Strategy (NES) proposes elimination of these programs, while acknowledging the critical role of the states.

Table 10 highlights the great disparity between the Administration's budget request and the Alternative Budget funding proposals.

Table 10

FY 1992 ALTERNATIVE BUDGET TECHNICAL AND FINANCIAL ASSISTANCE (000's)

Activity	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
International Market Development	$494	$600	$600
Joint Ventures	$0	$2,000	$2,000
Inventions and Innovations	$5,752	$6,013	$6,013
Municipal Energy Management	$1,990	$1,000	$1,000
Information and Communication	$1,393	$3,656	$6,156
Weatherization Assistance Program	$198,952	$24,000	$300,000
State Energy Conservation Program	$16,620	$2,200	$24,710
Institutional Conservation Program	$31,022	$3,800	$50,000
Energy Extension Service	$7,500	$0	$10,290
Program Direction	$20,293	$5,000	$23,000
Total	**$284,016**	**$48,269**	**$423,769**

TECHNICAL AND FINANCIAL ASSISTANCE - NEW INITIATIVES/EXPANDING CORE BUDGET

The following initiatives and explainations provide background on the importance of state and local assistance programs in reducing energy consumption by low-income households and thereby reducing fuel costs (see Table 11 for budget line item list of the initiatives).

Table 11

TECHNICAL AND FINANCIAL ASSISTANCE
New Initiatives/Expanded Core
(Additions to DOE Request)

Information and Communication	$2,500,000
Weatherization Assistance Program	$276,000,000
Institutional Conservation Program	$46,200,000
State Energy Conservation Program	$22,510,000
Energy Extension Service	$10,290,000
Program Direction	$18,000,000

Information and Communication ($2.5 million)

The Energy Information Administration (EIA) conducts periodic surveys of energy use and efficiency-related characteristics of residences, commercial buildings, personal vehicles, and manufacturing facilities. These surveys are a critical source of energy use and efficiency data. Additional funding is needed to expand sample sizes, produce better regional data, and track the markets for specific energy conserving technologies, particularly for commercial buildings. Also, additional funding is needed to begin work on a survey related to freight transportation. In the budget breakdown for EIA, these activities are called Energy Markets and End Use.

Weatherization Assistance Program ($276 million)

The low-income Weatherization Assistance Program (WAP) is administered by energy offices and weatherization assistance program offices at the state level. It works in partnership with States and local service organizations to increase the energy efficiency of and reduce energy consumption by low-income residences. DOE estimates that 22 million households are eligible to receive assistance under this program and need its services. However, through 1990, only 4 million low-income homes were weatherized by this program and the other assistance programs.

Since 1983, federal funds for this program have been reduced from $245 million to low of $161.3 million in FY 1990. As with the State and Local Assistance Programs, the Administration request is practically a phase out of federal funds for WAP. The rationale for low federal funding levels relies on state expenditure of oil overcharge funds.

Congress has consistently maintained funding despite the efforts over the last eight years to eliminate this program. We urge Congress to repeat the strong funding support shown in 1991 with an increase to $300 million. This funding recommendation will prompt the authorizing committee to increase WAP's current $200 million authorization level cap. Weatherization programs provide long-term solutions to reducing low-income energy bills. For every $1 spent on weatherization, over $3 is generated in the local community. For every $1 million spent, 69 jobs are created!

WAP activities provide direct financial assistance for weatherization, and technical assistance to improve techniques for identifying and installing the most cost-effective measures in single family and multi-family dwellings as well as for mobile homes. WAP also provides client education, information sharing and networking services for local service organizations.

State and Local Assistance Programs

State energy offices provide a wide range of energy related services to all sectors of the United States economy. Much of this work is conducted under the auspices of three federal energy conservation programs: 1) the State Energy Conservation Program (SECP); 2) the Institutional Conservation Program (ICP); and 3) the Energy Extension Service (EES). These programs promote increased energy efficiency for industry, small business, schools, hospitals, transportation, agriculture, and residential sectors. The federal funds provided for these programs and low-income Weatherization increased last year for the first time in a decade to over $247 million. These four programs received $557.6 million in FY1979, and if the funding had been adjusted to keep pace with inflation it would total approximately $950 million today. SECP, EES and ICP have been cut from $205 million in FY1980 to approximately $47 million in FY1991.

Last year, Congress recognized the importance of these programs when it passed the "State Energy Efficiency Programs Improvement Act of 1990" (P.L. 101-440), which was the first update to these major energy programs in a decade. This statute will allow greater flexibility to states in leveraging funds and permitting more innovative financing techniques for projects. This legislation also mandates that each state engage in energy emergency preparedness planning. In addition, the legislation will encourage technology transfer (especially to small businesses), promote the development of alternative motor fuels, expand industrial energy efficiency programs, and expand assistance for not-for-profit institutions. The statute also creates a State Energy Advisory Board to assist the Department of Energy improve the flow of information, technology and ideas between the Department, the DOE Laboratories, states, business, industry and the residential sector. The Board will also advise the Department on the direction that conservation and renewable energy programs should take.

The proposed appropriation levels in the Alternative Conservation Budget are consistent with the authorization levels contained in P.L. 101-440. Strong federal funding for these programs is critical in light of the tremendous energy savings and cost-effectiveness of these programs. A few examples are provided below which demonstrate to value of ICP, SECP and EES programs.

Institutional Conservation Program ($47.8 million)

The ICP program nationwide has provided 50 percent matching funds to schools and hospitals to install energy efficiency improvements in tens of thousands of institutions at energy savings many times the investment. Every state has success stories in the operation of this program and it permits money to be shifted from energy costs to education and medical care in the affected schools and hospitals.

For example, in Massachusetts, ICP grants totalling $23 million have been awarded since the programs inception. In one recent Illinois project at Grant Hospital, $55,616 in matching funds were provided to install variable speed chilled water pumping with an estimated annual energy cost savings of $31,235. Evaluation of the overall ICP program indicate that the conservation projects typically pay back in three years, implying that the lifecycle savings will be many times the initial cost.

Iowa, and now a number of other states, have used the federal ICP funds not only for 50 percent matching grants, but to stretch the money even further, by providing technical assistance while funding a loan pool through Norwest bank to provide master lease financing of energy improvements. Other states using innovative financing for energy projects in schools, hospitals, local governments, business and industry include Colorado, Massachusetts, Michigan, Mississippi, Montana, New York, Oregon, Utah, etc.

State Energy Conservation Program ($20.91 million)
Energy Extension Service ($10.29 million)

The SECP and EES programs also are a primary source of funds for innovative state energy efficiency programs. Without federal support, states in tight budget times or with deficits, would be hard-pressed to maintain these critical, long-term investments.

For example, state energy offices in California, New York and Oregon have been taking the lead role in passing and implementing new energy efficient building codes and standards. In addition, Washington recently passed tougher energy standards and many states are implementing these programs using SECP and EES funds. In Idaho, the energy office is sponsoring 36 free statewide training sessions for builders, code officials and others to acquaint them with their new residential standards.

SECP funds were used by Oregon to establish the Business Energy Tax Credit Program to finance efficiency improvements in 2,500 businesses in the State, which has generated more than $205 million in energy project investments. The annual energy savings resulting from this program are estimated to be over $68 million. New York's Energy Advisory Service to industry has conducted thousands of technical energy audits coupled with low-interest loans providing yearly estimated energy savings of $50 million. Similar programs are operating in California, Maine, Massachusetts, North Carolina, Pennsylvania and Washington.

Program Direction ($18.0 million)

The alternative budget proposes that Congress fund management positions in accordance with previous funding levels for program direction of the technical and financial assistance programs. These positions support joint ventures with state governments to promote energy efficiecny and renewable resources. In addition, the ten regional DOE offices need personnel funding to facilitate implementation of DOE programs and to further assist state and local agencies administer federal funds.

CE POLICY AND MANAGEMENT

The Alternative Budget proposes a modest increase of $2 million to the Policy and Management division of the Assistant Secretary's Office (see Table 12's and 13). These programs will facilitate technology and information transfer between government, industry and community leaders.

Table 12

FY 1992 ALTERNATIVE BUDGET
POLICY AND MANAGEMENT (000's)

Activity	FY 1991 Actual	FY 1992 DOE Request	FY 1992 Alternative
Salaries	$1,300	$1,315	$2,315
Contractual Services	$750	$1,410	$2,410
Small Business Innovation Research	$0	$875	$875
Total	**$2,050**	**$3,600**	**$5,600**

Table 13

POLICY AND MANAGEMENT
New Initiatives/Expanded Core
(Additions to DOE Request)

Conservation and Renewable Energy Fellowships	$1,000,000
Innovative Community Planning	$1,000,000

Conservation and Renewable Energy Fellowships ($1.0 million)

The objective of this project is to increase personnel exchanges and academic and technical ties between the federal government, national laboratories, universities, and industry. The main activity funded by this program would support graduate study and post-doctorate fellowships in academic disciplines related to energy conservation and renewable energy and to develop career paths for promising scientists, engineers to choose fields related to conservation and renewable energy. In addition, funds should be provided for the DOE to work with technical and industry groups to determine the feasibility of a sabbatical program whereby representatives of industry and technical associations could work at the DOE sharing their business expertise with the Department and improving the effectiveness of its technology transfer activities.

This program will sponsor thirty fellowships in energy efficiency. DOE currently supports graduate study by sponsoring national fellowship programs in many of its offices including the Offices of Fusion Energy, Nuclear Energy, Defense Programs and Civilian Radioactive Waste. A comparable program for conservation and renewable energy is long overdue. For example, there are very few scientists with expertise in absorption refrigeration technology. Not only are there only three research centers for this vital area, but the pace of current development is greatly hindered by the lack of availability of trained personnel.

Innovative Community Planning ($1.0 million)

Funding should be provided to the Departments of Energy, Housing and Urban Development, Transportation, and the Environmental Protection Agency for a cooperative program designed to facilitate the planning of energy efficient and environmentally sound communities. Sustainable developments consider the transportation and energy use of new communities as part of the planning process. For example, transit planning, guidelines for residential and commercial buildings, preservation of natural habitat, and integrating residential, commercial and light industrial land uses should be included in this planning.

To achieve this end, the aforementioned Departments should work with states and municipal governments to encourage the sustainable development in communities throughout the United States.

Cummins Engine Company, Inc.

Box 3005
Columbus, Indiana 47202-3005 Telephone 812 372 7211

May 10, 1991

The Honorable James H. Scheuer
Chairman
Committee on Science, Space, and Technology
Subcommittee on Environment
U. S. House of Representatives
2466 Rayburn Building
Washington, D. C. 20515

Dear Mr. Chairman:

This letter is written to register support for Department of Energy programs focused on developing heavy duty diesel engine technology, to request your help in expanding these programs as they relate specifically to increased fuel economy, and to request your assistance in establishing a new national technology initiative directed towards reducing emissions from diesel engines to levels below any possible significance. I will briefly outline our current view of the DOE programs related to emissions and fuel economy, will highlight new technology opportunities to impact emissions and fuel economy, and will define approximate funding requirements for effectiveness (based on most efficient teaming of industry, university and national laboratory researchers).

As you may know, Cummins makes about one half of the heavy duty truck engines used in the U.S. We also have a large share of off-highway markets (agricultural, marine, logging, power generation, etc.) and are a mainstay of military transportation power. Well over 17,000 Cummins engines were used in the Gulf War. These engines were used in all Bradly Fighting Vehicles (operational readiness among the best of all systems in the Gulf), 5-ton trucks, Multiple Launch Rocket Systems, Marine Amphibious Vehicles, and Armored Earth Movers and were also used extensively in heavy duty trucks, power generation units, and other applications. We are a multinational independent company (U.S. open market ownership) with about $3.5 billion in annual sales. Of this business, about $1.4 billion is overseas, so we make a significantly positive contribution to the trade balance. Our only business is diesel engines and related components. We are the largest independent diesel engine manufacturer in the world. We pride ourselves in being a world technology leader, particularly with respect to emissions reduction and fuel efficiency. Since we are in the business of providing clean, fuel efficient, durable, cost-effective power to our customers, we continually search for improvements to our diesel engine systems and fuels. We also continually seek alternative power delivery systems that might be more attractive to our customers and could, therefore, provide us with a competitive edge.

The DOE plays an important role in supporting the continuous improvement of diesel engines. This role is deeply appreciated but it is small now and should be expanded. Broadly, the industry provides regular technical briefings to DOE describing the state of our technology and our view of the most significant technical opportunities. The DOE evaluates this information, in context with similar information from other resources, and establishes prioritized program topics against which they allocate their budget. Specific projects are then placed through open competitive bid. Very often the involvement of an engine manufacturer in a given project is required by DOE, and teaming arrangements are encouraged. In this way, a wide technical community is engaged in broader problems, and solid links are maintained to the agents of implementation (production).

This has been an effective strategy and has delivered several materials advances (e.g.,piston ring coatings), design advances (e.g., new piston and cylinder head concepts), and analytical tools (e.g., combustion modelling with respect to particulate formation and transport). In general, these programs are well conceived, well managed, well connected to industrial competitiveness, and well distributed to the community of potential contributors. Concepts that do not live up to their initial promise are regularly replaced with new and more promising concepts. Cummins and the diesel community benefit directly from these projects in that we are able to conduct specific long range research that could not be adequately supported with internal funds. In addition, these projects support strong working relationships between our engineers and a large network of capable industrial, university, and national laboratory colleagues, whose interest has been attracted to the diesel engine technology.

To date, the DOE programs on diesel related technology have been so small (the total DOE program is less than $5 million/year, compared to nearly $144 million spent by Cummins alone on R & E in 1990) that only very small problems have been addressed effectively. In the past, that may have been appropriate. Now, however, the cascading effects of fuel consumption and emissions, combined with the recent emergence of large government supported engine systems programs in Europe and Japan, indicate clearly that the U.S. Department of Energy's role in transportation technology needs to be sharply increased.

State-of-the-art engineering understanding teaches us that there is a direct relationship between fuel economy (combustion efficiency) and maximum cylinder pressure, so that high pressure combustion systems will consistently have higher potential combustion efficiency than low pressure systems. Spark ignited (pre-mixed air and fuel) engines are all currently limited to relatively low cylinder pressures, in order to avoid detonation. In diesel-type engines, however, combustion rate is determined by the rate of mixing of fuel and air during the combustion process, and much higher cylinder pressures can be achieved. Since these differences are not fuel-unique, we believe that there are and will always be fundamental fuel efficiency advantages favoring diesel type engines over spark ignited engines, even under changing fuel scenarios. We also believe that by far the most effective short term way to minimize the CO2 contribution from the transportation sector to the greenhouse effect is to burn fuel more efficiently. We believe that diesel technology offers the most accessible path to this fuel efficiency over the next 10 years.

The principal widespread objection to this strategy continues to be the perception that diesel fundamentally pollute more than other engine systems. The challenge, then, is to deal with both the facts and the emotions around this perception.

There are four pollutants of concern. Carbon dioxide contributes to the greenhouse effect and is produced by combustion of all hydrocarbon fuels. State-of-the-art diesels, because they are more efficient in burning fuel than any other transportation power system, produce less carbon dioxide per unit of work done than any other available system. Continued development of diesel technology (piston and ring materials, turbocharger technology, high pressure fuel injection technology) will increase this advantage. Current DOE efforts focus on this theme, as the historical charter of their work, but badly need to be expanded to at least $10 million annually. In addition, the traditional DOE focus on "next generation" concepts (such as "adiabatic" or low heat rejection concepts) should be supplemented with a broader attention to all system improvements that shows solid promise of contributing to fuel efficiency. The huge fuel efficiency gains (more than 25% consumption reductions) in production diesel engines over the last 15 years were derived from a series of small but sophisticated component and system improvements. Each of these changes were solidly based on improved fundamental understanding gained from careful and imaginative research. This technology is not yet mature, by far. The rate of technology improvement, based on fuel economy and emissions data tracked over the past 15 years, is still increasing. (Also note that fuel economy commercially available today, from diesel engines, exceeds even the most optimistic projections for advanced alternative engine systems.)

Other pollutants of conern are unburned hydrocarbons, oxide of nitrogen, and particulates. Unburned hydrocarbons are the "white smoke", the "diesel exhaust" that can be seen and smelled and are not a necessary feature of modern engines. They are a result of cold temperatures, transients, poor engine adjustment, or a combination of these. Oxides of nitrogen (NOx) contribute to acid rain, and particulates have been implicated in health effects. All of these pollutants are currently produced at historically low (and steadily decreasing) levels by modern diesel engines. The heavy duty diesel industry is, in fact, reasonably likely to be able to meet legislated 1994 emissions levels. However, there are some very real questions concerning our ability to fund work adequate to meet reduction beyond 1994 even though we believe that all of these pollutants might be reduced below the level of any possible significance through a sufficiently intense R & D program with that specific agenda. Such a program would explore the limits of NOx and particulate formation in diffusion flame ("diesel") combustion, would seek ways to manipulate and control this type of combustion, and would seek NOx aftertreatment systems that could respond promptly to diesel engine transients and would be effective in the high oxygen diesel exhaust. The program would also develop technology to closely match fuel and air quantities during engine transients and would drive development of new oils that would not contribute heavily to particulates.

The DOE is aware of these needs and is making good use of available funds to address them. However, we estimate that a credible minimum diesel emissions technology development effort (critical mass for effectiveness) would equal or exceed the effort to design and develop a new diesel engine based on existing technology, or about $100M and 7 years. An emissions technology development effort would be much different from an engine development effort in that it would ideally involve a large group of capable people from our national technical resource base and would be a joint venture (cost shared) between DOE and the diesel industry. Funding requirements from DOE would probably be on the order of $15M annually for 7 years (or $10M annually for 10 years). A well managed program would start at this level and would then be examined annually for productivity and new requirements revealed by results achieved. Broad industry participation and guidance would be required for success.

Such a project is well beyond the current DOE budget and out of the question for an individual engine manufacturer in today's business environment, where virtually every U.S. diesel manufacturer is struggling with the financial burdens of a depressed economy, trucking deregulation, successive emissions regulation (each step change requires re-designing entire product lines) and our (successful) repelling of foreign competition. This is not an expensive project, on the other hand, relative to similar projects in England, Germany and Japan, and it is a very small investment relative to historical expenditures on other technologies that have yet to make measurable impact on heavy duty transportation and, therefore, have had absolutely no impact on fuel conservation or emissions reduction.

We agree, in fact, with the U.S. national strategy of worldwide leadership in emissions reduction. So far, however, this strategy is largely a regulatory and punitive one. We badly need to supplement and support this strategy with a well focused and appropriately founded national trust to help develop and demonstrate the enabling technology.

Sincerely,

G. D. Nelson

G. D. Nelson/ijd
Vice President R & D,
Chief Technical Officer

STATEMENT OF
THE AMERICAN GAS ASSOCIATION
BEFORE THE
SUBCOMMITTEE ON THE ENVIRONMENT
COMMITTEE ON
SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ON THE FY 1992
DEPARTMENT OF ENERGY
RESEARCH AND DEVELOPMENT BUDGET

April 9, 1991

Introduction

Mr. Chairman and Members of the Subcommittee: The American Gas Association (A.G.A.) is a national trade association comprising some 250 natural gas distribution and transmission companies serving over 174 million natural gas consumers throughout the United States. We appreciate this opportunity to present our views on natural gas-related research, development and demonstration (RD&D) conducted or sponsored by the Department of Energy (DOE).

The American people recognize that greater energy security, improved air quality and energy efficiency are essential to a strong U.S. economy and helping us retain a competitive edge. Enactment of the Clean Air Act Amendments (CAA) and the various national energy strategy (NES) initiatives are a first step in reaching these goals.

Sharing the view that natural gas is an essential component to an effective energy policy, the natural gas industry developed strategies and assessed resource needs to make this fuel a key element in enhancing our nation's future energy security and environmental quality. Focusing on efficiency and emissions-related RD&D of gas equipment and processes, and on the gas supply/demand outlook, the gas industry identified funding levels necessary to contribute to a sound national energy strategy while helping to attain environmental goals. It rapidly became evident that, given the scope of natural gas technology development, the current natural gas contribution to the national energy economy, and the heightened concern with the environment, the federal government should give natural gas-related RD&D a larger and much higher priority in DOE's policy initiatives and yearly budget.

To define the goals of energy security, clean air and energy efficiency, the gas industry is proposing a 10 year RD&D program that truly supports the efforts and ideals laid out in the CAA and the NES. To inaugurate this program, the natural gas industry is recommending an authorization of $214.9 million for all DOE gas-related RD&D in Fiscal Year (FY) 1992. This includes programs in DOE's Fossil, Conservation and Renewable Programs. $81.4 million of our total request falls under this subcommittee's jurisdiction. The primary thrust of this major expansion of natural gas related federally-funded research is to develop the technology that will allow natural gas to make a major contribution to the nation's environmental and energy security needs. Natural gas cannot fulfill its potential without the proposed RD&D.

The Importance of Gas-Related Research

As an abundant domestic resource, natural gas can play a significant role in the nation's energy balance and has the potential to make a meaningful contribution in cleaning up the environment. Natural gas is our nation's cleanest burning fossil fuel -- its combustion emits virtually no particulates or sulfur oxides, and it produces far lower emissions of ozone precursors, carbon monoxide, and other pollutants per unit of energy than coal or oil. In addition, A.G.A. and the DOE National Energy Strategy estimate that natural gas could displace up to 1.7 million barrels of imported oil per day within 10 years. An A.G.A. analysis is attached. Intensified RD&D programs focused on gas utilization technologies appropriately backed by continuing gas supply RD&D must be undertaken in order to expedite and expand this schedule and derive the accompanying environmental benefits.

Past efforts of the gas industry along with DOE have repeatedly demonstrated the value of investing in gas-related RD&D. These efforts have led to progress in end-use technologies such as low-NO_x combustion systems, cofiring, fuel cells, gas heat pumps, gas absorption chillers, and natural gas vehicles, and in supply research such as tight formations and coalbed methane.

Therefore, the gas industry recommends that Congress and DOE undertake a long-term (10-year) natural gas RD&D program funded at $2.5 billion to augment the planned industry funding. Programs should include: stationary emissions and efficiency solutions; transportation fuel alternatives and emissions solutions; electrochemical energy conversion; and gas supply enhancement. A comprehensive 10 year program is necessary to provide a level of consistency in research efforts that can support projects through to their completion and commercialization.

To initiate these programs we recommend that Congress authorize $214.9 million in FY 92 for natural gas RD&D. These funds should be allocated as follows: (1) $165 million in DOE's fossil and conservation programs for natural gas utilization programs to accelerate the availability of new technologies and reap the associated environmental, energy security and conservation benefits. $49.9 million in DOE's fossil program is needed to support a continuing natural gas supply RD&D program. This will supplement gas industry, gas equipment manufacturer, and producer efforts with estimated funds in the range of $200 million and $215 million in FY 92 for utilization and supply, respectively.

This natural gas industry initiative requires funding only for those technologies that are essential and prudent for the orderly development of advanced and new gas utilization and supply methods and processes that will enhance greater energy security, improved air quality and energy efficiency. Recent events in the Middle East underscore the need for better utilization of our nation's indigenous resources. This recommendation for a total amount of $214.9 million is required because of the increasing urgency to promote low pollution end-use technologies and fuel efficiency. This in turn will help meet more ambitious national objectives that will take us into the 21st Century.

We believe it is imperative that members of the Subcommittee work closely with the Appropriations Committee to assure that these programs are brought to fruition. There is a striking imbalance between the amount of natural gas used in the United States and the amount of RD&D funding natural gas receives. Natural gas supplies about 23 percent of America's energy needs, yet the federal government spent just over $117 million for FY91 on gas-related R&D, out of a total DOE R&D budget of approximately $1.8 billion. In contrast, nuclear power provides about 7 percent of the nation's energy and received over $503.2 million, while coal supplies 25 percent of the energy and received about $680 million in FY91. Please understand we are not attempting to identify or recommend the source of funds needed to meet the increased federal funding for natural gas RD&D.

Co-Funding of Research

The natural gas industry advocates that the private and public sectors share responsibility for funding RD&D. Where feasible, market incentives drive RD&D funding by an industry. However, in the case of secure energy, a clean environment and energy life-cycle efficiency, markets do not adequately recognize those benefits that accrue to the nation as a whole. This results in lack of industry funding at the conceptual and proof of concept stages for viable technologies. This early life-cycle stage is where government must recognize its long term responsibilities by heavier than normal participation in the RD&D process. It has to be understood by government that, by achieving a balance in energy technology choices, the nation as a whole benefits, not just the direct users of the technology.

Traditionally, the R&D phases are the lowest component of the total path from basic research to successful commercialization. When a product progresses to the stage where the technology is ready to be transferred from the laboratory into the commercial market -- that is the logical point that industry takes on a higher percentage of funding. Therefore, legislation must not predetermine the federal share of the cost of a project at any particular stage in its development.

The regulated gas industry supports organizations that promote specific technologies. GRI is the natural gas industry's cooperative research and development organization with membership from the pipeline, local distribution company and producer segments of the industry. Through GRI, together with co-funding by gas utilities, the gas industry already matches the amount of DOE gas RD&D funding. The American Gas

Cooling Center, the Natural Gas Vehicle (NGV) Coalition and NGAGE (Natural Gas Alliance for the Generation of Electricity) devote their efforts to commercialization of specific types of gas equipment and applications. The A.G.A. Laboratories also successfully perform R&D that has direct application to appliance and equipment innovations. IGT has established a Sustaining Membership Program in which over 50 gas companies support mid-term research directed toward a wide variety of projects, primarily in gas utilization.

However, relative to attaining environmental goals and improving U.S. energy security, these industry-funded RD&D programs are limited by available funds. Inevitably, projects with greater benefits for gas users and realistic chances of early commercialization are pursued while more far-reaching projects that have a potentially high impact on society cannot be funded. In addition to the development of new gas technologies, demonstrations and other technology transfer activities are necessary to ensure that the money spent in the research is not wasted. The gas industry has developed a solid record of success in transferring technologies to commercial use. We have worked with numerous manufacturing/commercialization partners to address the long list of issues to be overcome before successful transfer can take place. Yet many promising candidates remain, requiring further support to move from the laboratory to the marketplace.

Specific Funding Recommendations for FY 1992

GAS UTILIZATION R&D: $165.0 MILLION

(1) Fuel Cells ($62.0 million)

Natural gas-powered fuel cells convert the energy content of gas directly into electricity and by-product heat using a highly efficient electrochemical process. The electrical conversion efficiency of gas-powered fuel cells is approximately 15-20 percent greater than the conversion efficiency of traditional electrical generation. Fuel cells are also environmentally benign, generating very little noise and vibration, and emitting virtually no pollutants.

A total of $38.5 million should be used to support accelerated RD&D for molten carbonate fuel cells and $10.5 million should be used for accelerated and focused development of solid oxide fuel cells technologies. Furthermore, $2.0 million should be allocated for intensified development of solid polymer (proton exchange membrane) fuel cell technology. This is a promising new approach to the development of fast-response, compact fuel cells with low temperature heat rejection, suitable for electric power generation in stationary as well as mobile use. An additional $2.0 million should also be allocated to applied fuel cell research covering projects aimed at using solid polymer cell concepts in small-scale electric power generation, and projects that seek to improve the reliability and life of critical fuel cell components. To date, the gas and electric industries and DOE have jointly invested over $200 million in R&D for phosphoric acid fuel cells. We therefore, recommend a vigorous technology transfer program for these fuel cells funded at $9 million.

(2) Heat Engines ($6.9 million)

A.G.A. recommends an RD&D program in DOE's Heat Engine Program for the development of high efficiency natural gas-powered turbines in a wide array of sizes for electric generation. Such a program should include advanced combined cycle turbines, steam-injected gas turbines (STIG) and intercooled steam-injected gas turbines (ISTIG). The ISTIGs, in particular, are approximately fifty percent more efficient than conventional powerplants, cost half as much as new coal or nuclear plants and can make great contributions to the nation's air pollution problems. The need also exists for RD&D efforts aimed at other engines. Such efforts must adapt the latest liquid-fueled engine technology to dedicated natural gas engines that produce shaft power for water pumping, gas compression and various industrial and commercial applications.

(3) Coal and Waste Cofiring/Reburn ($8.5 million)

Cofiring of coal with natural gas provides a fraction of its total heat input and results in significant SO_2 and NO_x reductions. Reburn technology is aimed primarily at reducing powerplant NO_x emissions. Unlike cofiring, reburn technology injects natural gas into a zone beyond the primary combustion zone to create a gas rich reburn zone. Pilot scale tests indicate gas reburning in cyclone boilers could potentially reduce NO_x emissions by more than 60 percent. This is particularly significant as no other validated NO_x reduction technique exists for these boilers. Combining reburn with sorbent injection results in both NO_x and SO_2 reductions.

The gas industry applauds the efforts of DOE in supporting the development of cofiring technologies as part of its Clean Coal Technology Program. The gas industry encourages DOE to continue its program to support further advances of cofiring technologies such as NOXSO, a dry regenerative sorbent process, and the Parsons catalytic reduction process to reduce NO_x and SO_2 by levels greater than 90 percent.

Cofiring technology applications to industrial processes and waste-to-energy plants have not yet been addressed by DOE. Developments in these areas are at the early stages, but will require significant funding to support technology advancements. We therefore recommend $8.5 million for coal and waste cofiring and reburn applications.

(4) Combustion System/Emission Control ($17.8 million)

Because of the importance of this program to the nation as part of its energy strategy and in response to recently-adopted Clean Air Act legislation, $17.8 million is needed to accelerate and focus combustion and burner RD&D efforts aimed at developing low emissions gas equipment for residential, commercial, industrial, and utility applications. This includes high-efficiency, low-emissions burners, burner systems, and new methods of post-combustion control for new as well as retrofit installations.

Our recommendation includes: $6.0 million for the development of new methods of post-combustion emissions control that will promote the search for practical, low-cost solutions to typical retrofit/add-on needs of electric generation and industrial process facilities; $5.3 million for co-funding accelerated research specifically focused on utility electric generation (UEG) and enhanced oil recovery (EOR) operations using natural gas combustion equipment; and $6.5 million for the residential/commercial end-use sector.

(5) Natural Gas-Powered Heat Pumps and Desiccant Cooling ($18.0 million)

The gas heat pump provides heating and cooling in a single unit, using less energy than a conventional or high efficiency furnace uses for heating alone. Current performance estimates suggest that in heating, the gas heat pump could save one-half of the gas used in a conventional furnace and one-quarter of the gas used in a high efficiency furnace. The gas heat pump is attractive because it can provide cost-effective cooling in most warm regions where electric prices and demand charges are structured to discourage load growth. In addition, use of gas heat pumps could help to level cyclic gas and electric demand profiles, favorably affecting utility operating expenses and the cost of energy to the consumer.

More research is necessary to develop highly-efficient, reliable and cost-effective gas heat pumps for residential and commercial applications. Specifically, research in basic heat pump processes and phenomena, advanced working fluids and materials, use of non-ozeotropic refrigerant mixtures, advanced absorption systems for large commercial chiller and liquid and solid desiccants, is needed to put the advantages of gas heat pumps to work.

(6) Industrial Processes ($18.8 million)

We recommend $7.8 million to demonstrate newly developed processes in real-world industrial environments, not laboratories. Several innovative concepts, which promise to revolutionize the manner in which process heat is generated in the industrial sector, are under development and will be available for technology transfer within the next two years. Applied RD&D efforts, funded at $4.0 million by DOE are also proposed to improve efficiency, productivity and product quality in industrial gas-fired equipment and processes through the application of advanced combustion, heat transfer and controls technology. The gas industry is also recommending that $6.0 million be allocated for research and development focused on low emissions of natural gas combustion equipment for this sector. These funds will cover activities to help extend application of technologies employed in UEG/EOR end-use sectors to industrial processes and to obtain fundamental understanding on the formation and recombination of pollutants. Continuing ceramic material RD&D funded at $1 million is also needed to address several technical issues that have impeded wide market penetration.

(7) Natural Gas Vehicles (NGVs) ($27.0 million)

Use of alternative-fuel vehicles, including NGVs, is being required by the Clean Air Act and various National Energy Strategy initiatives. Accelerated research on novel gas compression concepts, funded at $10 million, is required to advance the development of compressor technology that will facilitate the growth of the necessary natural gas refueling network. Research must also be conducted on advanced storage systems, such as sorbent materials, to increase the understanding of gas storage technology, particularly the fundamental principles of natural gas adsorption, absorption, clathration and catalysis.

In addition, $15 million in DOE funding is also needed to conduct accelerated technology transfer on a variety of NGVs in many medium and heavy duty applications. To be most effective, such technology transfer activity requires that the government purchase and operate NGVs for its fleet.

(8) Advanced Research & Technology Development (ARTD) ($6.0 million)

The Advanced Research and Technology Development program generally supports basic research in combustion chemistry, engineering concepts, advanced process development, and materials and components that provide a technology base for ongoing fossil energy projects. Current research needs include: development of advanced high-temperature materials capable of resisting chemical attack from sodium and chlorine for application in glass and aluminum melting; development of inexpensive and durable catalysts to bring natural gas catalytic combustion closer to practical implementation; improving the understanding of the interaction of gasification catalysts with carbon/steam and carbon/hydrogen reactions; developing advanced processes for low-cost synthesized gas; developing lower-cost acid-gas cleanup processes; continuation of efforts to assess advanced technology for alkali metals, particulates and tars; and biological and catalytic production of high-value chemicals.

GAS SUPPLY RD&D: $49.9 MILLION

DOE's continuing involvement in gas supply research is essential to ensure the recovery of a larger percentage of the total domestic gas resource base. Our recommendation of $49.9 million for FY 92 shows no increase above the industry's recommended FY 91 funding levels and is predicated on the continuation of the gas supply research programs recommended for FY 91.

Estimated consumption of natural gas in 1989 was 19.3 quads. Current domestic production is running at about 17.8 quads annually with the balance of demand met by other sources such as storage, supplemental gaseous fuels, and natural gas imports.

The amount of gas that can be recovered from the total gas resource base is directly contingent upon the ability to develop new tools and techniques to recover this gas at commercially viable prices. This resource base is made up of reserves and resources. The recovery of gas in the "resources" category requires discovery and development of **new** technology on the basis of an improved understanding of reservoir geology. Of the total resource evaluated in the lower-48 states 564 Tcf is judged economically recoverable at 1987 wellhead prices of less than $3/Mcf. An additional 131 Tcf of gas is judged economically recoverable in a price range of $3 to $5/Mcf.

(1) Unconventional Natural Gas ($23.8 million)

Devonian shales and tight sands are estimated to contain up to 1,800 Tcf and 900 Tcf of natural gas, respectively. Tight formation gas is produced using advanced recovery techniques, such as hydraulic fracturing. A.G.A. estimates that favorable economic conditions and substantial investment in advanced recovery techniques could increase the accessible gas resources and improve the economics of production.

In order to maximize the amount of natural gas recovered from our abundant resource base, basic geoscience research must be expanded. This research should be aimed at increasing our knowledge of the geological/geochemical/geophysical characteristics and parameters of both conventional and unconventional formations. Moreover, because of the potentially enormous size of what we call advanced unconventional natural gas resources, extensive research is necessary to verify how much may be technologically and economically recoverable.

To enhance the development of technology necessary to recover the gas from unconventional gas formations, more research must also be conducted to develop and refine advanced stimulation and drilling techniques (directional and horizontal). Field testing and a technological database must also be established. We are recommending funding of $23.8 million in the unconventional gas recovery program to continue DOE's secondary gas recovery program and ongoing research activities in western tight stands, Devonian shales, and other complex formations and to support expanded geoscience-type research.

(2) Surface Coal Gasification ($8.5 million)

For surface coal gasification to make a significant contribution to gas supplies, gasification techniques must be developed to accommodate high-sulfur Eastern coals and combustion-inhibiting coal "fines." Research must be conducted to develop techniques for gasifying these "fines," for disposition of liquid byproducts, and for consolidated "fines" and tars for utilization. Scientific and engineering feasibility studies of advanced generation gasification processes must also be conducted to develop a technological database for such processes.

(3) Geopressured Methane ($9.6 million)

Geopressured methane is found in either a free state or dissolved in water and trapped in sedimentary rock at higher-than-normal pressures. One of the largest geopressured areas underlies a portion of the Texas and Louisiana Gulf Coast. Estimates of the total resource in-place range up to 6,000 Tcf; however, estimates of the amounts of gas that might ultimately be recovered, given current recovery techniques, range between 10 and 150 Tcf. If technological breakthroughs can be achieved, geopressured methane could become another major source of domestic energy.

Research conducted by DOE in geopressured/geothermal zones is focused on producing both gas and electricity from low-grade heat in the reservoir brine. DOE should redirect its research efforts and concentrate on recovering the vast amount of dissolved methane found in geopressured zones. In addition to DOE's current geopressured program, DOE should develop new approaches that utilize traditional engineering principles to maximize gas production and minimize brine production.

(4) Biofuels ($8.0 million)

Since the supply of organic and waste materials is virtually unlimited, supplemental methane supplies from biomass and waste conversion can add significantly to the total future gas supply picture. In addition, controlled production and use of methane from these sources can reduce the natural release of methane from the decay of these waste materials. This decay is a substantial contributor to the overall rate of methane emissions to the atmosphere that contribute to the greenhouse effect. Finding sites for disposal of municipal solid waste is an increasing problem in communities across the nation. Therefore, developing energy from municipal solid waste and other biomass would promote the environmental benefit of productive use of currently "useless" materials. However, the quality of the gas produced and a suitable processing technique are important concerns that inhibit the widespread use of these potential gas resources.

The gas industry fully supports the gas-related biofuels R&D being carried out at the Solar Energy Research Institute (SERI) and recommends strong federal support for continuation of these important activities. Advances have been made in both the thermochemical and biochemical conversion processes, but more extensive studies and technology advancements are necessary to fulfill biomass' contribution as a usable source of energy.

Conclusion

The natural gas industry recognizes the continuing budget deficit places severe constraints on federal energy research dollars. However, increasing natural gas RD&D will more equitably match the contribution natural gas supplies to the nation's energy mix and will yield both short- and long-term environmental and energy security benefits for the nation.

DOE FY 1991 & 1992 Gas-Related Budget
Major Gas-Related Supply and Utilization Research Programs
($ Millions)
(As of 2/12/91)

	FY 1990 Congress. Approp.	FY 1991 DOE Request	FY 1991 Gas Industry Recomm.	FY 1991 Congress. Approp.	FY 1992 DOE Request	FY 1992 Gas Industry Recomm.
Gas Supply						
Unconventional Natural Gas	14.6	13.7	23.3	15.97	8.0	23.8
Surface Coal Gasification	23.7	8.5	8.5	15.12	5.4	8.5
Underground Coal Gasification	0.8	0.5	0.5	.794	0.0	0.0
AEPT*	4.0	4.5	-	4.67	3.0	-
Biofuels	8.6	2.5	8.0	4.6	6.3	8.0
Geopressured Resources	6.0	2.9	9.6	6.0	2.5	9.6
Subtotal	57.7	32.6	49.9	47.15	25.2	49.9
Gas Utilization						
Fuel Cells (Gas Related)	30.1	7.1	40.5	36.02	22.4	62.0
Heat Engines	0.0	0.0	2.9	0.0	0.0	6.9
Combustion–Cofiring/Reburn	2.5	0.0	8.5	0.0	0.0	8.5
Combustion–System/Emiss. Cont.	0.0	0.0	0.5	0.0	0.5	17.8
Conservation (Heat Pumps, Cooling, Industrial Processes)	25.4	17.8	16.8	25.1	16.7	36.8
Natural Gas/Diesel Vehicles	2.5	4.0	10.6	5.5	12.5	27.0
ARTD (Gas Related)	4.7	3.9	6.0	3.9	1.0	6.0
Subtotal	65.2	32.8	85.8	70.52	53.2	165.00
TOTAL	$122.9	$65.4	$135.7	$117.67	$78.3	$214.90

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*Advanced Extraction and Process Technology - Geoscience research has traditionally been folded into this line item.

A.G.A. American Gas Association

Planning & Analysis
Issues

Issue Brief 1991-3

January 16, 1991

The Role of Natural Gas in Offsetting Oil: 1991 Update

A. Introduction

The invasion of Kuwait in August has brought the subject of U.S. dependence on oil imports to the forefront again. America now imports about half of the oil that it consumes. Most oil is used in the transportation sector, however, a large volume of fuel oil is also used in stationary applications: for space heating; for industrial process and boiler use; and for electricity generation. Oil use in stationary applications (excluding feedstocks) in 1989 amounted to 4.9 million barrels per day (b/d), or the equivalent of 68% of annual crude oil imports. Distillate and residual fuel oil, the oil products most likely to be offset by gas, make up half of that total. In contrast, natural gas is essentially a domestic resource with over 40 years of conventional supply under current consumption rates and the potential to extend the resource base well beyond the next century.

The purpose of this analysis is to demonstrate the extent to which natural gas can directly contribute to national energy security by substituting for oil in existing applications. This study updates a similar analysis published by A.G.A. in 1988. This analysis was prepared on a market-by-market basis over different time horizons: 30-day (immediate); 1 year; 5 years; and a 10-year potential. This analysis estimates oil displacement potential - it is not a forecast. Such levels would only be achievable if government policy actively promotes natural gas.

B. Executive Summary

In an emergency or oil supply disruption scenario natural gas could immediately offset 130 thousand barrels per day (mbd) of distillate and residual fuel oil in stationary applications. Within a year the rate of displacement could increase to 420 mbd as significant penetration in the dual-fuel capable boiler markets accumulates. After five years, the combination of growing conversions in the residential and commercial buildings sector (mainly on the East Coast) and further penetration in boiler and process markets would raise the penetration rate to 1.0 million b/d. If a comprehensive government initiative was begun now with a 10-year horizon, it is estimated that 1.5 million b/d of fuel oil use could be offset by the end of the decade. Adding 240 mbd that would, in effect, be offsets of gasoline use in fleet vehicles in the transportation sector, would bring total oil displacement by natural gas to 1.7 million b/d after 10 years.

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An important component of this initiative would be increased natural gas pipeline capacity into oil-dependent regions. The volume of current planned natural gas pipeline capacity would go substantially toward accomodating the projected level of oil displacements over five years. To achieve the ten year goal, a similar increment in pipeline capacity and an increase in gas storage capacity would be needed. The exact size of the increment is dependent upon seasonal load factors and upon the volume of additional gas load that would derive from economic growth and other new sources.

The highlights for each stationary market and for the transportation sector for each succeeding timeframe are as follows and summarized in Table 1:

- The residential market for fuel oil is essentially distillate oil use concentrated on the U.S. East Coast, particularly in the Middle Atlantic census division which accounts for 5.6 million of the 11 million oil-heated households. Conversions from oil to natural gas heat already comprise the single largest source of residential conversions annually. Based on previous conversion growth rates it is possible to envision 350,000 conversions in the first year, displacing 20 mbd, rising to 500,000 conversions annually by the fifth year, resulting in oil offsets of 100 mbd after five years. If the annual rate of conversions then holds at 500,000, the cumulative potential impact after 10 years would be the displacement of 225 mbd of distillate fuel oil use -- roughly half of the current consumption level. This ten year goal would require additional pipeline and storage capacity and distribution mains given the seasonality and location of this load.

- In the commercial market, both distillate and residual fuel oil are used - primarily for spaceheating, but also for water heating in large multi-family buildings. Similar to the residential sector, commercial fuel oil consumption is also concentrated on the East Coast, but to a lesser extent. In the event of an oil supply disruption, displacement of oil use in dual-fuel boilers could reach 25 mbd. After a year, the displacement of all oil in gas-served buildings, as well as in a portion of the more than three million multi-family units with gas service nearby, would increase the offsets to 100 mbd. With increased penetration in the multi-family sector, the offsets could reach 190 mbd after five years and as much as 250 mbd after 10 years, or nearly 65 percent of the current level of commercial fuel oil use.

- The industrial market is the largest stationary market for fuel oil. Even after discounting those oil applications for which natural gas is not suited for displacement (such as feedstocks, asphalt and vessel bunkering) there remains nearly 900 mbd of distillate and residual fuel oil use in boiler and process applications that theoretically could be displaced by natural gas. Oil offsets could rise from 50 mbd in the immediate term to 200 mbd after a year. This would occur predominantly in dual-fuel boiler applications where gas and residual oil, in particular, are intensely competitive. After five years, when gas penetrates more into the applications using distillate oil, the offsets are projected to increase to 400 mbd. If there is, in fact, a policy designed to minimize the use of oil in industrial applications, the extension of gas service to a high proportion of what had formerly been unserved customers could potentially see the level of offsets reach 600 mbd after 10 years. While certainly a large volume, this would only be about 15 percent of all the oil consumption (including LPG) in the entire industrial market and two-thirds of the residual/distillate oil use. Like the residential and commercial sectors, displacement of oil in the industrial market to meet the ten year goal will require significant new construction of pipeline and distribution infrastructure. Seasonal service arrangments would also have to be enhanced.

- Fuel oil consumption (almost entirely residual oil)in the electric utility market is heavily concentrated on the East Coast. Over 80 percent of this oil consumption occurs in the three census divisions along the Atlantic. Unlike the industrial market, which is made up of thousands of customers and more widely distributed, the number of power plants involved is relatively small. About 125 of the 290 or so power plants that use fuel oil are on the East Coast -- and some of these plants are already dual - fuel capable. Consequently, the potential for oil offsets rises quickly from 50 mbd in the very short - term to 300 mbd after five years. With a concentrated national effort, three - quarters of fuel oil consumption could be offset in 10 years, reaching 400 mbd. Given the location of these plants, it is likely many plants would choose to be dual-fuel capable, interruptible gas customers. Thus complete displacement of oil year-round would be unlikely.

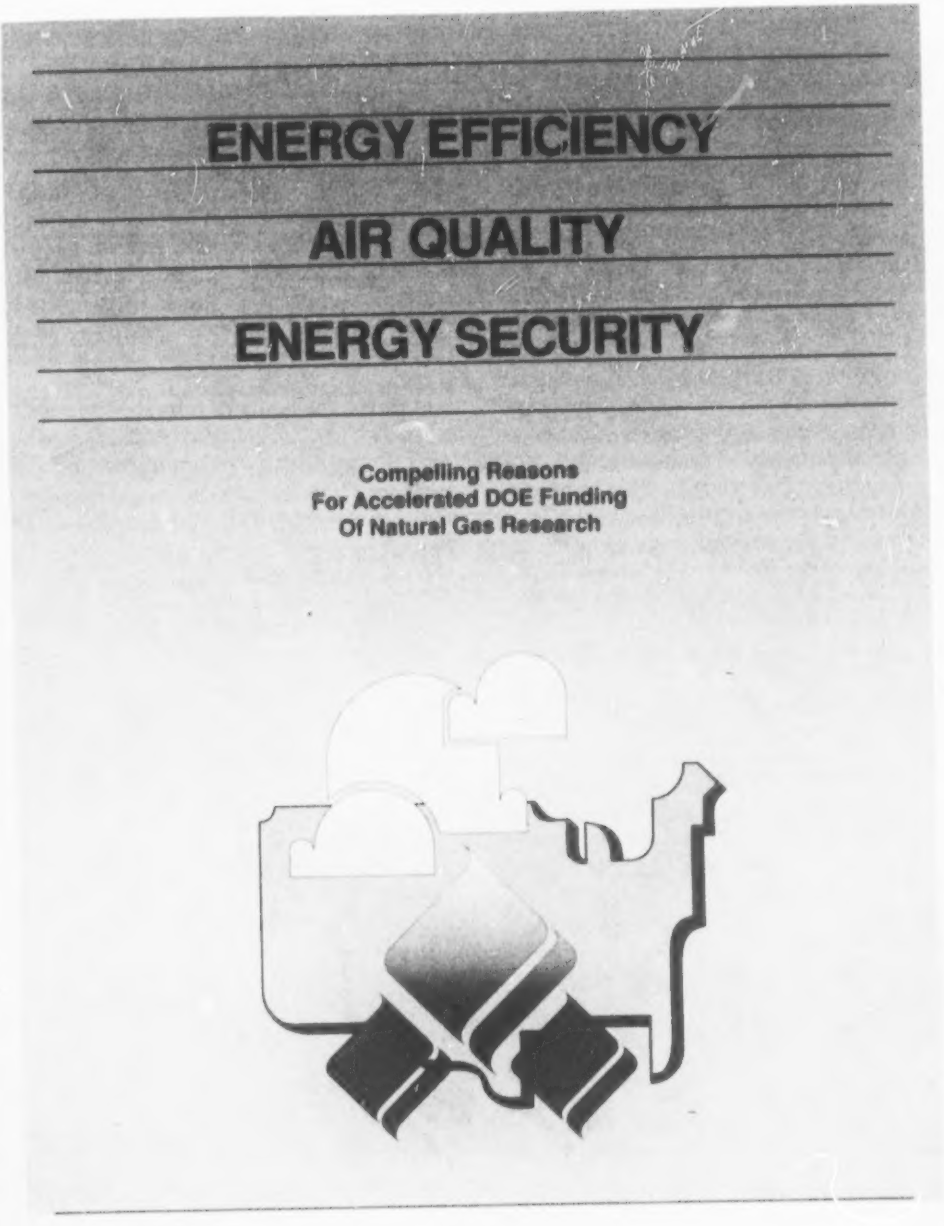
- In the transportation sector the displacements would be limited in the early years, reflecting the fact that a natural gas vehicle (NGV) manufacturing and fuel distribution infrastructure is now beginning to develop. The oil displacement rate would move up from minimal levels in the first five years, rising quickly by the end of the decade to 240 mbd as 2 million centrally-refueled fleet vehicles in major urban areas convert to natural gas. The passage of the Clean Air Act of 1990 alone will spur oil offsets in the transportation sector.

Table 1

Potential Oil Substitution
(thousand barrels/day)

Stationary Sources	**Immediate**	**One-Year**	**Five-Years**	**Ten-Years**
Residential	5	20	100	225
Commercial	25	100	190	250
Industrial	50	200	400	600
Electric Generation	50	100	300	400
Subtotal	130	**420**	**990**	**1475**
Mobile Sources				
Vehicles	-	-	5	240
Total	130	**420**	**995**	**1715**

Note: NGV market penetration grows dramatically after five years as a result of the new Clean Air Act legislation which begins to take effect in 1995. A.G.A. forecasts that by the year 2005 natural gas vehicles could displace as much as 675 mbd.



ENERGY EFFICIENCY

AIR QUALITY

ENERGY SECURITY

Compelling Reasons
For Accelerated DOE Funding
Of Natural Gas Research

INTENSIFIED NATURAL GAS UTILIZATION RD&D PROGRAM WILL BENEFIT NATION

The development of a National Energy Strategy and revisions to the Clean Air Act have combined to place a high priority on increasing U.S. energy efficiency and improving air quality. Concurrently, there is a growing consensus that natural gas, as a secure and plentiful domestic resource, must play a larger role in meeting our nation's future energy needs.

Reliance on Fossil Fuels

The combustion of fossil fuels has been the central component of our nation's energy mix for many years. Fossil fuels are projected to continue to be the predominant choice of energy users for the foreseeable future. The Department of Energy (DOE) estimates, for example, that fossil fuels will provide over 80 percent of our total energy needs in 2010. But concerns about air pollution – including human health hazards, acid rain, ozone depletion and climate change – must be addressed now if we are going to meet the growth challenges of the 21st century.

The increased use of natural gas in place of more polluting fossil fuels will help improve air quality in much of the nation. The resulting demand for increased supplies can be met for more than a century by timely reserve additions (supported by improving exploration and production technology) to the current domestic base of economically recoverable gas resources.

In the future, significant advances in reducing combustion emissions – even from clean-burning natural gas – will be required to enable many large and growing metropolitan areas to meet federal clean air standards and to comply with state implementation plans.

Highly Efficient Technologies

Improvements in air quality can also be achieved through intensified research, development and demonstration (RD&D) programs focusing on highly efficient gas utilization technologies with very low levels of emissions. The U.S. natural gas industry, which serves over 175 million natural gas consumers throughout the nation, is already working hard to accomplish this goal. However, the Clean Air Act Amendments and recent developments in the Middle East demonstrate the need to rapidly accelerate this RD&D. The federal government must make a substantial commitment to assist in this effort as a partner with the natural gas industry.

Gas Industry Proposal to DOE

The American Gas Association (A.G.A.), the Gas Research Institute (GRI), and the Institute of Gas Technology (IGT) have joined major natural gas distribution utilities in proposing that the DOE launch an accelerated and focused RD&D program aimed at developing technical solutions to the air quality challenge many urban areas are facing as a result of continued economic growth. Through cost-effective improvements in the energy efficiency of gas equipment, processes and products, this program not only will enhance air quality, but also will help reduce energy costs to consumers, conserve energy, and enhance U.S. energy security.

In order to make these least-cost energy options available when they are needed, the gas industry is proposing that DOE establish a 10-year natural gas utilization RD&D program, with initial funding of $165 million in the 1992 fiscal year (FY 92). These funds will be devoted to reducing stationary emissions and improving the efficiency of natural gas combustion, developing dedicated natural gas vehicles, and developing fuel cell powerplants using electrochemical energy conversion. In addition, the gas industry is asking DOE to continue its support of the gas supply RD&D program at a level of $50 million in FY 92 to assure that adequate gas resources will be available in the future at competitive prices.

CONCERNS INCREASE FOR ENERGY EFFICIENCY AND AIR QUALITY

In statements submitted by the public for consideration in the National Energy Strategy, increased energy efficiency was the option identified by the most participants. It was seen as a way to reduce pollution, dependence on energy imports, and the cost of energy to American consumers.

Gas Utilization Efficiencies

The efficiencies of available natural gas utilization technologies vary considerable according to the application: 150 percent for commercial cooling, over 95 percent for residential heating, 70 percent for industrial cogeneration, and 45 percent for combined cycle turbine systems for electric generation. New heat pump technology, currently in the field-test phase, offers the potential for gas heating efficiencies exceeding 150 percent. The potential efficiency for electric generation, utilizing advanced natural gas-powered fuel cells or advanced combined cycle gas turbines, is projected at 60 percent.

In energy applications involving fuel combustion, further efficiency improvements must often be balanced against the low emissions levels that have to be maintained. Additional research is required on new methods, processes and equipment if further energy conservation and reduced emissions are to be achieved.

Controlling Emissions

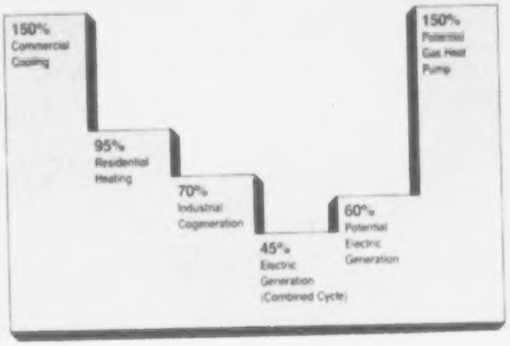
More than $30 billion is spent each year in the U.S. on emission controls and improved technologies to lower emissions. These efforts have been successful in reducing emissions since 1970, especially in urban areas. At the same time, continuing growth is causing many areas of the nation to fall short of achieving and maintaining National Ambient Air Quality Standards (NAAQS).

The Clean Air Act established NAAQS for six "criteria" air pollutants: sulfur dioxide, nitrogen oxides (NOx), particulate matter, ozone, carbon monoxide, and lead. Thanks to technological advances, ambient concentrations of most of these pollutants have decreased considerably in recent years. Nevertheless, many major cities across the country fail to maintain adequate air quality to meet the NAAQS for ozone and carbon monoxide.

For example, 68 cities failed to meet the December 1987 deadline for attainment of the ozone standards. This list included the "extreme" nonattainment category of .280 parts per million (ppm) or above (Los Angeles); the "severe" category of .180 to .280 ppm (Baltimore, Chicago, Houston, Milwaukee, Muskegon, New York City, Philadelphia, and San Diego); the "serious" category of .160 to .180 ppm (18 areas); and the "moderate" category of .138 to .160 ppm (32 areas).

Ozone is produced through chemical reactions that involve both NOx and volatile organic compounds. It has been proven hazardous to human health. Natural gas vehicles, supported by focused RD&D, offer one very promising solution to reducing ozone levels in urban areas.

Efficiencies of Available and Potential Gas Utilization Technologies



Acidic Deposition

Another common form of air pollution is known as acidic deposition, or acid rain. Sulfur dioxide and NOx are the main components of acid rain. They combine in the atmosphere to form acidic compounds. They may be deposited on the Earth's surface in dry form, or in rain, snow or fog.

The effects of acid rain on aquatic systems, forests, building materials, human health and visibility are a major public concern. Rainfall in much of the northeastern U.S. and southeastern Canada is more acidic than would occur in these areas without industrial pollution.

Electric powerplants (mostly coal-fired) produce nearly two-thirds of the total sulfur dioxide emissions throughout the country. Industrial processes and other fuel combustion also are major contributors. Natural gas used in combination with coal has the potential to significantly reduce sulfur dioxide emissions. In the case of NOx, the transportation sector is the largest contributor at 43 percent, followed by electric utilities at 35 percent. Further development of natural gas vehicles and low-emission combustion processes will contribute to future NOx reductions.

Clean Air Act Revisions

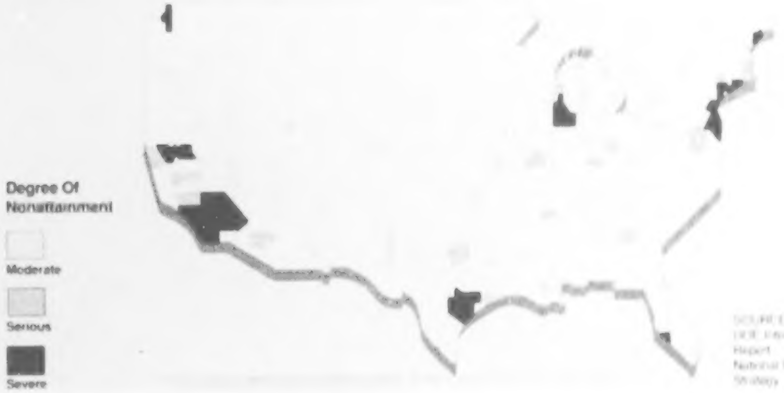
Faced with a growing public desire for improved air quality, the President and Congress worked many months to develop revisions to the Clean Air Act. This landmark legislation is designed to help bring areas throughout the nation into compliance with the NAAQS for various pollutants.

One important provision establishes new deadlines for areas to meet the NAAQS for ozone and carbon monoxide. The deadlines are based on the degree of nonattainment. Target reduction goals are set for interim periods. Meeting these and other implementation schedules established by the legislation will require the joint efforts of industry and DOE to develop and commercialize a wide variety of new energy-related technology.

Phased-in Tailpipe Standards

Since the transportation sector produces a significant share of air pollution, several provisions of the Clean Air Act Amendments are devoted to motor vehicles. The legislation establishes a series of

**Areas
In Which
Ozone Criteria
Were
Not Met
(1983-1985)**



SOURCE:
DOE Interim
Report
National Energy
Strategy

phased in vehicle tailpipe standards and mandates significant reductions to NOx and hydrocarbons. Another provision requires fleet vehicles to use cleaner fuels like natural gas, and established schedules for reducing emissions.

The revisions to the Clean Air Act create a significant potential market for natural gas vehicles, or NGVs. While NGVs are expected to meet the required emission levels, additional support is required before these vehicles can compete fully in the marketplace.

Technology Transfer

Technology transfer is an often overlooked aspect of RD&D programs, and has special relevance to the natural gas industry. Demonstrations and other technology transfer activities are necessary to make sure that the research investment pays off.

Manufacturers are often not in a position to take on high risks by trying new processes or manufacturing new products—even though they may offer efficiency and emissions improvements. The unfortunate fact is that many innovative technologies developed through U.S. research, including those needed to meet new environmental laws and regulations, remain unavailable in the marketplace.

Financial Assistance Needed

Consumers and manufacturers are often locked into older, less efficient and more polluting technologies for a variety of reasons. This inertia must be overcome if this country's environmental policies are to become effective while U.S. industry is enhancing its competitive position in the world economy. This can be done through government action to cover the initial marginal costs of new technologies, and through stable and predictable regulatory practices.

Federal assistance in technology transfer activities will help break the cycle and more rapidly translate the results of RD&D into useful products, equipment and processes. Accomplishing this goal, however, will require strong partnerships between the public and private sectors.

Acidity Of Wet Deposition (1996 Annual Average)

pH 4.6 - 4.4
pH 4.4 - 4.2
pH 4.2 - 4.1
pH 4.4 - 4.2
pH 4.6 - 4.4
pH 5.0 - 4.6
pH 5.8 - 5.0

Note: The lower the pH number, the more acidic the area is.

SOURCE: DOE Interim Report — National Energy Strategy

RESEARCH TO FOCUS ON COMBUSTION, VEHICLES, FUEL CELLS

Versatility of Natural Gas

The versatility and attributes of natural gas make it an ideal fuel to take advantage of the opportunities created by the National Energy Strategy and the Clean Air Act revisions. For example, it is the cleanest of all fossil fuels. It can substitute for other fuels for air pollution control. It can be used to reduce sulfur, nitrogen oxide and reactive hydrocarbon emissions, as well as carbon monoxide and carbon dioxide emissions of other fossil fuels. Used as a vehicular fuel, natural gas can reduce the major source of air pollution in most urban areas.

Natural gas also has economic advantages. For instance, it doesn't require the very large investments in processing facilities needed to convert many other fuels into a useful energy form. There is no need to mitigate energy efficiency losses common to the processing of other fuels after their extraction from the ground. A million mile transmission and distribution pipeline network provides an existing infrastructure to deliver natural gas to every region of the country.

Improving Technology

Even with the many advantages of natural gas, gas users would be unable to realize the full benefits of this versatile fuel without the continuing development of new technology. Gas industry research traditionally has been financed through cost sharing by private companies. This has been a necessity because the industry has received only modest support from DOE and the federal government. During 1992 the gas industry (including GRI, IGT, A.G.A., gas utilities, pipelines, producers and equipment manufacturers) plans to spend more than $400 million on gas utilization and gas supply RD&D.

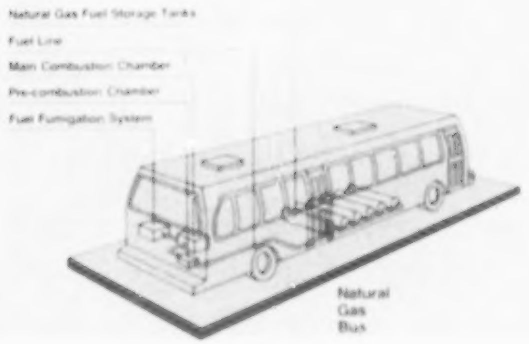
As successful as industry funded RD&D programs have been, they are inevitably limited by the availability of funding. Industry has typically selected projects with lower risk and the chance of early commercialization. Higher risk or more expensive projects with equal or potentially greater benefits for gas users have typically been left on the shelf. If natural gas is to fulfill its optimal role in the nation's economy, accelerated RD&D supported by increased federal funding will be essential.

Higher Funding Justified

The gas industry is asking DOE to conduct an accelerated natural gas RD&D program funded at a total of $2.5 billion over a period of 10 years. The resulting technology developed will provide substantial benefits to residential, commercial and industrial energy users throughout the nation for many years to come. For gas utilization, the initial funding request is $165 million for FY 93. This request encompasses increased DOE support for each major area of gas utilization RD&D.

Such increases are justified by the increased urgency to develop clean, low cost energy technology options for all consumers. These technologies will assist our nation in meeting the requirements of new clean air legislation and will help the U.S. meet and maintain national ambient air quality standards as our economy grows. The gas industry expects to more than match the government funding provided for RD&D.

The gas industry is asking the DOE to focus its FY 93 funding for end-use gas-related research in the following strategic areas:



Blower and Burner Controls
Air Filter
Burner Surface

Reducing Stationary Emissions

Research into improved, highly efficient and low emission combustion processes, low NOx burners and high heat transfer efficiency water heaters and natural gas cooling should lead to reduced emissions from stationary sources such as industrial boilers and residential space and water heaters. Programs should focus on using natural gas for emissions control, advanced combustion systems, fiber and catalytic burners, and cofiring and reburn for both coal and municipal solid waste systems.

Programs should also emphasize energy efficiency, as in advanced combined and simple cycle gas turbines. Other efforts that should be continued include the Advanced Research and Technology Development program that supports basic research in combustion chemistry, engineering concepts, and materials concepts, and energy conversion and utilization research that focuses on ceramics and other advanced materials.

Natural Gas Vehicles

Development of dedicated natural gas vehicles (NGVs), designed especially for fleet applications in urban areas, could contribute to the substantial reduction in mobile source emissions that will be required to meet future Clean Air Act standards. In addition, NGVs can help reduce our reliance on foreign oil.

Natural gas is much cleaner than conventional fuels, but focused RD&D is needed to improve natural gas storage and refueling technologies along with technology transfer assistance to demonstrate NGVs in a variety of applications. Higher engine efficiencies will further reduce pollutants.

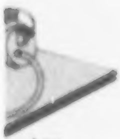
Electrochemical Energy Conversion

Fuel cells can produce electricity with a fraction of the atmospheric contamination of conventional, fossil fuel-based electric generation. Technology transfer assistance for first generation phosphoric acid fuel cell powerplants together with rapid development of second and third generation fuel cells (molten carbonate, solid oxide and solid polymer) will lead to highly efficient, virtually non-polluting, small-scale powerplants. Since these powerplants can be deployed on site, they will reduce the need for large electrical generating plants and transmission networks.

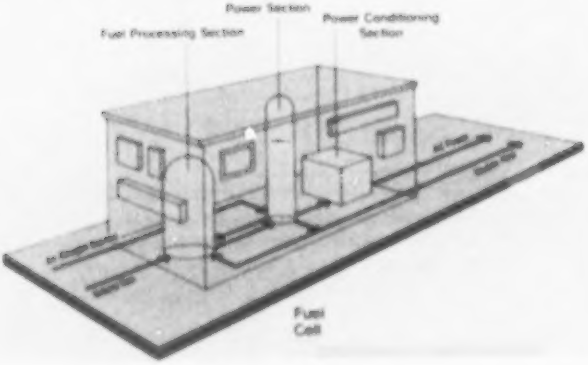
Such fuel cells also could potentially power vehicles in the 21st century, and with virtually no emissions.

DOE's Enlarged Role

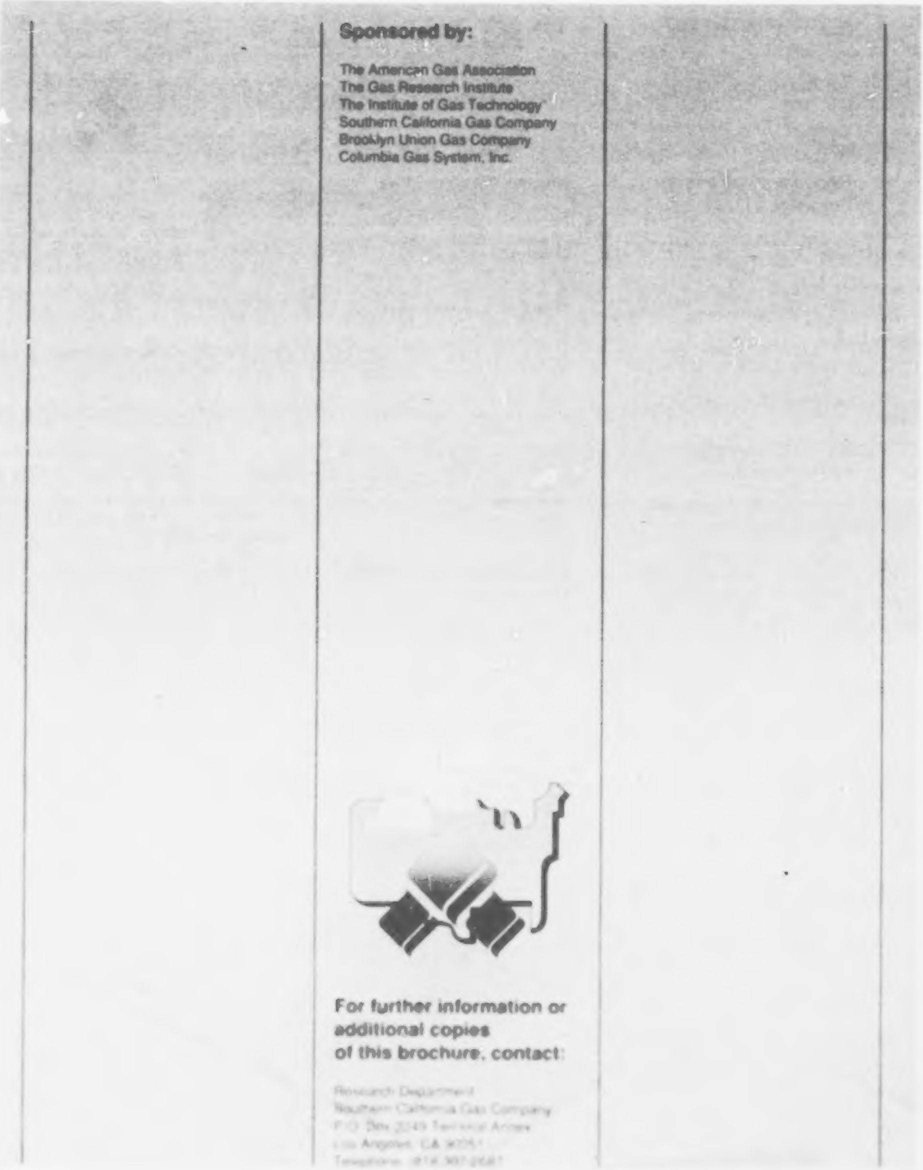
The gas industry believes that DOE must play a greater role in gas technology development. This kind of research will facilitate energy conservation and more efficient use of our abundant resources. It will contribute to our energy security by reducing our reliance on foreign oil. It also will support economic growth by maintaining a viable, vibrant economy and by enabling U.S. industry to compete in the global marketplace more effectively, using our own resources while reducing pollution.



Low
NOx
Burner



Fuel
Cell



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U.S. DEPARTMENT OF ENERGY FISCAL YEAR 1992 FUNDING

FOR

NATURAL GAS AIR QUALITY, EFFICIENCY AND SUPPLY RESEARCH, DEVELOPMENT AND DEMONSTRATION

Recommendations Prepared by

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Attachment A

U.S. DEPARTMENT OF ENERGY
FISCAL YEAR 1992 FUNDING
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EXECUTIVE SUMMARY

As an abundant domestic resource, natural gas can play a significant role in the United States' energy balance and has the potential to make a meaningful contribution in cleaning up the environment. Natural gas is our nation's cleanest burning fossil fuel--its combustion emits virtually no particulates or sulfur oxides, and it produces far lower emissions of ozone precursors, carbon monoxide, and other pollutants per unit of energy than coal or oil.

Intensified research, development and demonstration (RD&D) programs focused on gas utilization technologies appropriately backed by continuing gas supply RD&D must be undertaken in order to derive the above benefits. ***The gas industry recommends that the U.S. Department of Energy (DOE) undertake a long-term (10-year) natural gas RD&D program funded at $2.5 billion to augment the planned industry funding. To initiate this program, we recommend that DOE provide $215 million in Fiscal Year 1992 for natural gas RD&D. As shown in Attachment A, these funds must be allocated as follows:***

- ***$165 million for natural gas utilization programs to accelerate the availability of new technologies and reap the associated environmental, energy security and conservation benefits. The gas industry and gas equipment manufacturers will fund a projected $195 million planned for RD&D in FY'92.***

- ***$50 million to support a continuing natural gas supply RD&D program. This will supplement gas industry and producer efforts with estimated funds of $214 million in FY'92.***

Further advances in reducing combustion emissions--even from clean-burning natural gas--are required to enable a large number of areas to meet federal clean air standards and to comply with state implementation plans as their local economies and resultant emissions grow. The DOE should thus prioritize its funding initiatives starting in Fiscal Year 1992 by providing for programs on:

- Stationary Emissions and Efficiency Solutions--Research into improved, highly efficient processes and equipment should lead to reduced emissions from stationary sources such as industrial boilers, furnaces and dryers, and commercial and residential space conditioners and water heaters. Programs should focus on using natural gas for emissions control, as in cofiring and reburn for both coal and municipal solid waste systems as well as advanced combustion systems including fiber and catalytic burners. Programs should also focus on energy conversion efficiency, as in advanced heat engines. These should be supported by continuing programs that build a technology base through basic research in combustion chemistry, engineering concepts, advanced materials, components and processes.

- Transportation Fuel Alternatives and Emissions Solutions--Development of dedicated natural gas vehicles initially concentrating on fleet use will contribute to the substantial reduction in mobile source emissions that will be required to meet future Clean Air Act standards and help decrease the country's dependence on foreign oil. Natural gas is much cleaner than conventional fuels but focused RD&D is needed to design vehicles for optimal performance, to demonstrate such vehicles in a variety of applications, and to develop natural gas storage and refueling technologies. As this RD&D effort progresses, further improvements in natural gas engine efficiencies will further reduce critical pollutants.

- Electrochemical Energy Conversion--Fuel cells produce electricity with only a fraction of the atmospheric pollution and at considerably higher efficiency than combustion-based power plants. This program seeks technology transfer assistance for first generation fuel cell development and accelerated research for second and third generation fuel cells aimed at introduction in 1995 and 2000, respectively. These advanced fuel cell technologies will provide even greater efficiency improvements, and can be deployed on-site in various sizes as modular, highly efficient and virtually non-polluting power plants. Another concept, the solid polymer fuel cell, promises to be a compact and highly efficient device. With accelerated RD&D, it could be introduced after the year 2000 as a vehicular powerplant with virtually no emissions.

- Gas Supply Enhancement--To maintain a supply capable of meeting future demand at competitive prices, the on-going development of tools and techniques to help ensure the economical recovery of a larger percentage of the total domestic gas resource base must continue. RD&D must thus pursue gas extraction and recovery technologies that offer the potential for large increases in domestic gas supply. This should be complemented with continuing research that seeks to develop techniques for extracting higher quality gas from biomass.

This initiative by the natural gas industry contributes toward greater energy security, improved air quality and energy efficiency which are essential to a strong U.S. economy and competitive edge. The recent events in the Middle East underscore the need to seek better utilization of our nation's indigenous resources. This recommendation for a total amount of $215 million for gas utilization and supply RD&D in Fiscal Year 1992 is required because of the increasing urgency to promote low pollution end-use technologies and fuel efficiency. This in turn will help meet more ambitious national objectives that will take us into the 21st century.

INTRODUCTION

The U.S. natural gas industry serves over 175 million natural gas consumers throughout the nation. In support of Federal efforts toward formulating a national energy strategy and a stronger environmental policy, the American Gas Association (A.G.A), the Gas Research Institute (GRI), and the Institute of Gas Technology (IGT) have joined some of the nation's major gas utilities to submit this proposal to DOE for an intensified research, development and demonstration (RD&D) program for natural gas utilization technologies seeking higher fuel efficiency and very low emissions. This program will benefit the nation by developing technical solutions to the air quality challenges many areas face. Backed by appropriate gas supply RD&D, it will promote greater energy security for the nation through the utilization of clean, domestic energy resources.

In 1989, the A.G.A, a national trade association comprised of some 250 natural gas distribution and transmission companies, submitted comments to the Department of Energy (DOE) discussing the goals of the national energy strategy and how, by refocusing DOE's energy research agenda, natural gas could make a greater contribution to the nation's energy security and environmental goals[1]. With air pollution contributing to various human health hazards, acid rain, ozone depletion and climate change, the issue of air quality has emerged as a strong environmental concern. Confident that natural gas can be part of the solution to the air pollution and energy security problems our nation faces, the nation's largest natural gas distribution utilities, also submitted testimony to DOE[2]. It recommended that federally sponsored increased natural gas utilization RD&D be made an essential component of the national energy strategy.

In April 1990, DOE issued its Interim Report[3] on the National Energy Strategy. This report contained a compilation of public comments which identified **increased energy efficiency as the "loudest single message"** conveyed by over 1,000 written submittals in response to the government's request for input. According to the report, "energy efficiency was seen as a way to reduce pollution, reduce dependence on foreign oil, and reduce the costs of energy". The Interim Report also noted that nationally, more than $30 billion is being spent yearly on emission controls and improved technologies to reduce emissions. Such efforts have been successful in reducing emissions since 1970, especially in urban areas. However, continuing growth is also causing many areas of the country to fall short of achieving and maintaining the National Ambient Air Quality Standards (NAAQS).

Sharing the view that natural gas is an essential component to an effective energy policy, the natural gas industry developed strategies and assessed resource needs to make this fuel a key element in enhancing our nation's future energy security and environmental quality. Focusing on efficiency and emissions-related RD&D of gas equipment and processes, and on the gas supply/demand outlook, the gas industry identified funding levels necessary to contribute to a sound national energy strategy while helping to attain environmental goals. It rapidly became evident that, given the scope of natural gas technology development, the current natural gas contribution to the national energy economy, and the heightened concern with the environment, **the Federal government should give natural gas-related RD&D a larger and much higher priority in DOE's policy initiatives and yearly budget.**

The focus of DOE's research and development activities historically has been on coal and nuclear energy; in contrast, natural gas RD&D has received only minimal support from DOE and is, by necessity, cost-shared by private companies. For example in 1992, the gas industry and equipment manufacturers plan on spending over $195 million for gas utilization RD&D and at least $215 million for gas supply RD&D. These expenditure forecasts are more than 5 times greater than the FY 1991 DOE budget request for RD&D in these two areas.

At the same time, the past efforts of these participants have repeatedly demonstrated the value of investing in gas-related RD&D. These efforts have led to progress in end-use technologies such as low-NOx combustion systems, cofiring, fuel cells, gas heat pumps, gas absorption chillers, and natural gas vehicles, and in supply research such as tight formations and coalbed methane.

Further, the regulated gas industry also supports organizations that promote specific technologies. GRI is the natural gas industry's cooperative research and development organization with membership from the pipeline, local distribution company and producer segments of the industry. GRI plans, manages and raises funding for a comprehensive program in natural gas supply, distribution and utilization. Through GRI, together with co-funding by gas utilities, the gas industry already matches the amount of DOE gas RD&D funding. The American Gas Cooling Center, the Natural Gas Vehicle (NGV) Coalition and NGAGE (Natural Gas Alliance for the Generation of Electricity) devote their efforts to commercialization of specific types of gas equipment and applications. The AGA Laboratories also successfully perform R&D that has direct application to appliance and equipment innovations. IGT has established a Sustaining Membership Program in which over 50 gas companies support mid-term research directed toward a wide variety of projects, primarily in gas utilization.

However, relative to attaining environmental goals and improving U.S. energy security, these industry-funded RD&D programs are limited by available funds. Inevitably, projects with greater benefits for gas users and realistic chances of early commercialization are pursued while more far-reaching projects that have a potentially high impact on society cannot be funded. If natural gas is to take the proper place in the nation's energy strategy, sustained accelerated RD&D is needed in these projects to increase end-use efficiency, and to lower emissions, supported by continuing research to increase energy supplies. Federal funding is the key to such accelerated research and development.

In addition to the development of new gas technologies, demonstrations and other technology transfer activities are necessary to ensure that the money spent in the research is not wasted. The gas industry has developed a solid record of success in transferring technologies to commercial use. We have worked with numerous manufacturing/commercialization partners to address the long list of issues to be overcome before successful transfer can take place. Yet many promising candidates remain, requiring further support to move from the laboratory to the marketplace.

Federally assisted technology transfer activities described in more detail in the section on specific RD&D funding recommendations will help more effectively translate the results of RD&D into widely accepted products, equipment, and processes. As pointed out in the DOE Interim Report, this can only be accomplished by building stronger partnerships between the public and private sectors.

THE IMPORTANCE OF GAS-RELATED RD&D

The United States needs an adequate DOE-funded natural gas research, development and demonstration program to meet future energy needs, reduce national security risks, and to help achieve ambient air quality standards in many areas of this country as well as to enable U.S. industry to remain competitive in today's world economy.

Natural gas can fill this important role because its attributes make it the most desirable fuel in a myriad of applications. Natural gas is the cleanest of all fossil fuels. Gas can be used as a substitute fuel for other fossil fuels to strengthen air pollution control, to reduce sulfur (SO_2) and nitrogen oxide (NO_x) emissions, as well as to control carbon monoxide and carbon dioxide emissions of other fossil fuels. Natural gas can also be used as a transportation fuel and thus help reduce the major source of air pollution in most urban areas. No other single fossil fuel is comparable to natural gas in producing environmental benefits across multiple applications.

The million-mile transmission and distribution pipeline network of the natural gas industry provides a safe and growing infrastructure to deliver environmental improvements to every region of the country. Further, natural gas can be converted into usable energy more efficiently and inexpensively than most other fuels.

Pending clean air legislation provides further incentives for DOE to increase its funding for development of natural gas utilization technologies. The combustion of fossil fuels, the central component of our nation's energy mix, will continue to power our economy for the foreseeable future. To meet federal and state clean air standards, **significant advances in reducing emissions from combustion must be achieved.**

Such significant advances can be made while also improving energy efficiency. For example, further research on electrochemical processes and thermodynamics could improve the process for transforming gas into usable energy, with even greater efficiency and essentially no adverse environmental impact. DOE can and must play a major role in gas technology development. Focused research in strategic areas will allow for the more efficient use of an abundant domestic resource, and thereby reduce our nation's reliance on foreign oil. It will also facilitate economic growth by enabling U.S. industry to compete in the global marketplace more effectively, while reducing pollution and using our own resources.

The gas industry recommends that DOE move rapidly to accelerate the development of natural gas technologies. We urge DOE to join the gas industry in sponsoring a 10-year RD&D program to significantly increase the efficiency and environmental benefits of gas use. This joint effort should begin in FY 1992 with DOE funding $215 million for natural gas RD&D, and the gas industry funding over $400 million.

This program is fully consistent with three of the major goals identified by DOE Secretary James D. Watkins in the Position Statement and Budget Overview for FY 1991[4]. **Respecting the environment, increasing energy efficiency** and **fortifying foundations** are DOE goals that can significantly benefit from increased natural gas utilization technology development. Such technology development must also be fully supported by a continuing strong gas supply research and development program to help fulfill a fourth major DOE goal, namely to **secure future energy supplies.**

Both gas utilization and gas supply RD&D programs are described in more detail in the following sections of this FY 1992 budget recommendation by the gas industry. While the **Gas Utilization** section describes the recommended areas of intensified and focused RD&D in fossil energy and conservation, the **Gas Supply** section presents an FY 1992 proposal that is consistent with on-going DOE-sponsored research efforts. These recommendations are also fully supportive of the Gas Research Program Implementation Plan published by DOE in April 1990[5].

GAS UTILIZATION

The gas industry has always been in favor of funding levels that are consistent with sound fiscal policy. As shown in Attachment A, our recommendation of $165 million for utilization RD&D in FY 1992 will show increases above the FY 1991 gas utilization budget in fuel cells, natural gas vehicles, and low emissions combustion systems and energy efficiency-related conservation programs. Such increases are justified by the increased urgency to develop least-cost technology options for all consumers which will aid our nation in meeting the requirements of the new clean air legislation, and will help our nation enhance its energy security.

Specific Utilization RD&D Recommendations

The following are the gas industry's specific funding recommendations for gas utilization-related RD&D sponsored by DOE in FY 1992.

Stationary Emissions and Efficiency Solutions

1. Combustion System/Emission Control ($17.8 Million)

Because of the importance of this program to the nation as part of its energy strategy and in response to Clean Air Act legislation ultimately adopted, $17.8 million is needed to accelerate and focus combustion and burner RD&D efforts aimed at developing low emissions gas equipment for residential, commercial, industrial, and utility applications. This includes high-efficiency, low-emissions burners, burner systems, and new methods of post-combustion control for new as well as retrofit installations.

The DOE Interim Report identified the end-uses that are the biggest contributors to ozone precursor and acid deposition emissions[6]. These were electric power generation, industrial processes, and the transportation sector. The first two sectors typically have large capital investments in fixed facilities. Imposition of additional air quality regulations and controls preferentially results in retrofits and/or additions of equipment in such facilities rather than new projects built from the ground up.

In the absence of low emissions burner systems, post-combustion control methods are often used for emissions control as an interim measure for compliance with new regulations. For large installations, state-of-the-art post-combustion controls such as selective catalytic reduction (SCR) systems are very costly to install and to maintain.

Allocating $6.0 million for the development of new methods of post-combustion emissions control will promote the search for practical, low-cost solutions to typical retrofit/add-on needs of electric generation and industrial process facilities. With such funding matched on an equivalent basis by the gas industry, advanced post-combustion controls for burner systems would be available for interim or retrofit applications in 2 to 4 years. If sustained over several years, such levels of funding would also permit the development of application-specific post-combustion systems as the last step in emissions reduction in a given installation. Such systems would be optimized and integrated with the combustion process stream to derive required emissions reductions without compromising process efficiency.

The gas industry recommendation also includes an expenditure of $5.3 million for co-funding accelerated research specifically focused on utility electric generation (UEG) and enhanced oil recovery (EOR) operations using natural gas combustion equipment. This has arisen from a need in the non-attainment areas of the U.S. where the switching from coal or oil to clean natural gas combustion has already occurred in an effort to control air pollution. These areas are also the ones experiencing the most rapid population and economic growth. Further, they are faced with more stringent control measures in order to attain and maintain the National Ambient Air Quality Standards (NAAQS) and other potential provisions of the proposed Clean Air Act.

The recommended research will require development and demonstration of advanced burner concepts in the very large burner sizes that are typical of UEG and EOR boilers and fluid heaters. Concepts involving increased mixing, fuel and air staging, steam injection, and enhanced heat transfer have been proven effective both in increasing efficiency and in lowering emissions of small and medium size burner applications. A similar development effort is now needed for large (over 50 million Btu per hour) burner system applications to make such applications widely used in 5 to 10 years.

In the residential/commercial end-use sector, combustion R&D efforts in energy efficiency and equipment emissions must focus on developing reliable, durable, and inexpensive materials, burner systems, and controls. A funding of $6.5 million is needed for this effort which is designed to advance the technology of low emissions residential and commercial gas combustion equipment for market entry in 3 to 7 years.

Between supply and point of end-use, natural gas is the most efficient fossil resource used in many of these applications. Furthermore, the direct combustion of natural gas in residential and commercial equipment can produce substantially lower overall volumes of air emissions than the use of equipment supplied from conventional coal-fired electric power plants. However, if gas is to continue to be a viable end-use energy choice, lower emissions from gas combustion will be required in the near future, especially for appliances and equipment used in areas which have trouble meeting the NAAQS.

2. Industrial Processes ($18.8 million)
Industrial energy consumption represents approximately 36% or 29 quadrillion Btu (quads) of the total energy consumed in the U.S. in 1988. Natural gas is most heavily utilized in the industrial sector, representing more than 40% of the 18.6 quads of gas consumed in the U.S. in 1988.[7]

Based on the prominence of natural gas in industrial process applications and its preference by users, an RD&D effort by DOE to improve natural gas-fired equipment and processes is warranted. This effort must address: (1) improvements in efficiency, productivity and product quality of natural-gas-fired systems in order to maintain the competitiveness of U.S. industry in today's global economy and (2) development and evaluation of low emissions natural gas combustion equipment to meet existing and pending environmental regulations.

DOE funding of $7.8 million is recommended to demonstrate newly developed processes in real-world industrial environments, not laboratories. Several innovative concepts which promise to revolutionize the manner in which process heat is generated in the industrial sector are under development and will be available for technology transfer within the next two years. DOE funding will ensure that these environmentally sound and energy-efficient technologies contribute to the competitiveness of the American manufacturing sector in the world marketplace.

Applied RD&D efforts, funded at $4.0 million by DOE are also proposed to improve efficiency, productivity and product quality in industrial gas-fired equipment and processes through the application of advanced combustion, heat transfer and controls technology. Implementation of advanced technologies in industrial processes will provide important consumer benefits, including: (1) reduction of manufacturing costs through increased efficiency, productivity, and reduced storage, handling and preparation costs; (2) enhancement of industry's ability to expand operations and still comply with environmental regulations on combustion and process emissions; (3) stable gas send-outs and seasonal load balancing, which can help gas utilities control operating costs and pass on the savings to the consumers; (4) reduction in dependence on imported petroleum products; and (5) enhanced ability of U.S. manufacturing to compete in global markets.

The gas industry is also recommending that $6.0 million be allocated to address research and development focused on low emissions of natural gas combustion equipment for this sector. These funds will cover activities to help extend application of technologies employed in the UEG/EOR end-use sectors to industrial processes and to obtain fundamental understanding on the formation and recombination of pollutants. Such research would include second generation surface combustor concepts for process and thermal fluid heaters, improved glass tank furnaces using oxygen and natural gas cracking/oscillating burners, and industrial melters for scrap metal, mineral wool, and fiberglass production. This same technology can also be applied to ash vitrification, thus reducing potential waste disposal costs for a number of industrial processes.

Also, flue gas treatment technologies are not currently applied to industrial processes because they operate under conditions which are incompatible with temperatures and gas compositions encountered in most industrial operations. The investigation of methods to modify their range of operation, as well as the development of the above alternative emissions control technologies, will allow the cross-section of the American industrial complex that is currently most vulnerable to foreign competition to maintain its leadership while minimizing environmental degradation.

Substantial advances in energy technologies hinge on research and development of ceramics and other advanced materials. The advantages of structural ceramic materials versus metal alloys are well documented. Ceramics are ideal because they are lightweight, retain their strength at high temperatures, and have high corrosion and wear resistance.

However, continuing RD&D is needed to address several technical issues that have impeded wide market penetration. A funding level of $1 million is recommended for research to develop more systematic fabrication techniques for the forming and sintering of more reliable ceramic parts. Moreover, reproducible and cost-effective manufacturing and quality control techniques are needed for the large-scale production of reliable and inexpensive ceramic materials and components for a wide variety of high-temperature uses.

3. Natural Gas Cooling ($18.0 Million)

By extracting heat from the outside air and transferring it to the indoor space, gas heat pumps can actually supply more thermal energy than is contained in the input fuel. The gas heat pump's cooling effect is accomplished by reversing this process. The gas heat pump thus provides heating and cooling in a single unit.

Current performance estimates suggest that in heating, the gas heat pump could save one-half of the gas used in a conventional furnace and one-quarter of the gas used in a high efficiency furnace.[8] Furthermore, these devices offer the potential for lower resource energy consumption than systems powered by electricity produced from fossil fuels or nuclear energy. The gas heat pump is attractive because it can provide cost-effective cooling in most warm regions where electric prices and demand charges are structured to discourage load growth. In addition, use of gas heat pumps could help to level cyclic gas and electric demand profiles, favorably affecting utility operating expenses and the cost of energy to the consumer.

DOE-sponsored research co-funded by the gas industry is necessary to put these advantages to work through reliable and cost-effective gas heat pumps for residential and commercial applications. To improve their performance, reliability, maintenance and endurance, such research must include the evaluation of promising technical approaches, fundamental research in basic heat pump concepts, processes, phenomena, advanced working fluids and materials, along with research on generic component development. These activities must be integrated into overall gas heat pump system development and analysis.

Presently, research is being pursued at a slow pace because of the modest funding levels. Further improvements involve the use of non-azeotropic refrigerant mixtures in engine-driven systems with the potential for eliminating backup boilers or resistance heaters and offering high performance during both winter and summer operation.

To help accelerate technology transfer, it is also proposed that DOE sponsor technology transfer of heat pumps for residential and commercial applications, following gas industry field testing of these devices. In addition, DOE emphasis on engine emissions reduction would contribute significantly to engine-driven gas heat pump success.

DOE should also fund development of advanced absorption systems for large commercial chiller applications. Requiring no chlorofluorocarbon (CFC/HCFC) refrigerants, these systems can be a major contributor to both gas and electric utility integrated resource planning programs to yield significant energy savings if used on a widespread basis.

Desiccant materials have also been applied in cooling cycles, paralleling the performance of conventional residential and commercial electric cooling equipment. Further, desiccant cooling cycles also do not require the CFC/HCFC refrigerants in use with existing electric vapor compression systems. Desiccant cooling cycles introduce 100% fresh air to the conditioned space. This is an air quality health benefit because it helps dilute contaminants such as radon and tobacco smoke. Desiccant cooling cycles also have the inherent ability to control temperature and humidity independently. Such control of humidity can help avoid indoor air health hazards such as the growth of airborne bacteria and fungi.

Recommendations for DOE-sponsored research include development of liquid desiccants, solid desiccant composite materials, solid desiccants formulated into structural load-bearing shapes, and the engineering of desiccant performance. These avenues of technology development would complement and strengthen the current gas industry RD&D program and contribute to the competitiveness of this technology for environmentally sound, energy-efficient residential and commercial cooling.

4. Heat Engines ($6.9 Million)

Gas-fired heat engines can contribute positively to the environment and energy conservation. Therefore, the gas industry recommends intensified research and development under DOE's Heat Engine Program for the development of high efficiency natural gas-powered turbines in a wide array of sizes for electric generation. Such a program should include advanced combined cycle gas turbines, steam-injected gas turbines (STIG), intercooled steam-injected gas turbines (ISTIG) and chemically recuperated reheat gas turbines (IR-CRGT), as well as low emissions gas turbine retrofit equipment that helps avoid the costly alternative of post-combustion emission control.

The ISTIGs, in particular, are approximately fifty percent more efficient than conventional powerplants[9], cost half as much as new coal or nuclear plants and can help solve the nation's air pollution problems. Conceptual studies of the IR-CRGT turbine indicate that high efficiencies and very low emissions can be achieved using this technology[10] In this technology, some of the natural gas fuel is reformed using heat from the turbine exhaust, thus increasing system efficiency to levels as high as 60%. The presence of hydrogen in the fuel can decrease NO_x to below 5 ppm. The principal area for research is the development of an efficient reformer that operates at temperatures low enough for effective heat recovery from the turbine exhaust.

The need also exists for RD&D efforts aimed at other engines. Such efforts must adapt the latest liquid-fueled engine technology to dedicated natural gas engines that produce shaft power for water pumping, gas compression and various industrial and commercial applications[11]. This includes increasing efficiency and power output through improved combustion techniques, and reducing emissions while preserving performance through advanced controls, optimized components, and innovative exhaust treatment techniques.

5. Coal and Waste Cofiring/Reburn ($8.5 Million)

Basic cofiring of coal with natural gas involves the injection of gas into the boiler to provide a fraction of its total heat input. In recent full-scale tests this technique has reduced the amount of SO_2 emissions in a greater proportion than the amount of gas used in the boiler[12]. Further, testing has indicated that cofiring can also be effective in reducing stack opacity. Other potential benefits to be documented are start-up improvement, operating and maintenance cost reductions, peak capacity and availability improvements, turn-down capability increases, and boiler slagging/fouling control.

Reburn technology is aimed primarily at reducing power plant NOx emissions. Using gas as a small portion of the boiler fuel, reburn technology involves injecting that fuel into a zone beyond the primary combustion zone to create a natural gas-rich "reburn" zone.

Pilot scale tests indicate gas reburning in cyclone boilers could potentially reduce NO_x emissions by more than 60 percent 13. This is particularly significant as no other validated NO_x reduction technique exists for these boilers. Although the majority of cyclone units are over 20 years of age, utilities plan to operate many of these units for at least an additional 10 to 20 years. In addition, the majority of these units are in the Midwest, an area targeted for acid rain and ozone emissions control.

Gas reburn combined with dry sorbent injection (GR-SI) refers to combining reburn techniques with the injection of dry calcium-based sorbent to reduce both NO_x and SO_2 emissions. Combining gas reburn with sorbent injection is intended to reduce the cost and complexity of straight sorbent injection technology by reducing the amount of sorbent required for equivalent SO_2 reduction. This decreases the additional particulate burden on the plant's electrostatic precipitator. GR-SI is considered applicable to all boiler designs, is retrofitted more easily than scrubber technology, and may offer some site-specific operational enhancements.

The gas industry applauds the efforts of DOE in supporting the development of cofiring technologies as part of its Clean Coal Technology Program. The gas industry encourages DOE to continue its program to support further advances of cofiring technologies such as NOXSO, a dry regenerative sorbent process, and the Parsons catalytic reduction process to reduce NO_x and SO_2 by levels greater than 90%.

While utility applications are supported by the DOE's Clean Coal Technology Program, cofiring technology applications to industrial processes and waste-to-energy plants are not addressed. Developments in these areas are at the early stages, but will require significant funding to support technology advancements.

Potentially more stringent emission limits coupled with increased enforcement are expected for existing industrial boilers burning solid and liquid fuels or wastes. Gas cofiring offers emission reductions plus related operational enhancements such as improved load-following and greater fuel flexibility. Research is needed to develop gas burner system designs and guidelines for site-specific retrofit applications. Testing is needed to compare baseline system and cofiring technology performance and economics relative to competing approaches.

The combustion of municipal waste is expected to continue to increase in the 1990's both as a solid waste management option and as an energy source. New emission regulations are placing greater demands on new and existing municipal waste combustion sources. Natural-gas-based technologies can provide cost-effective emissions control options for two different applications. First, combustion improvements in existing municipal waste combustors (MWC) using basic cofiring of natural gas can result in reduced emissions of toxic organic species, such as polychlorinated dibenzo dioxins and furans. Pilot tests have shown that combustion conditions significantly affect trace organic emissions, and that natural gas cofiring can reduce such emissions. Combustion modifications based on natural gas cofiring can be a very cost-effective retrofit alternative to add-on controls for existing MWC plants.

At GRI, RD&D efforts have focused on cofiring natural gas and refuse-derived fuel (RDF). A field evaluation of RDF-gas cofiring is planned for early 1991. Further research is needed to develop and optimize this technique for other MWC configurations such as modular units and the mass burn moving grate, and then to demonstrate these technologies at full scale. Such full-scale demonstration must be proven if these alternatives are to be recognized as viable by users and regulators.

The second potential MWC application is the use of natural gas reburn for NO_x control. Pilot studies and tests have shown up to 60% NO_x reduction in MWC. This technology is ready for transfer to operational municipal solid waste incinerators. Gas industry co-funding is available but further RD&D funding from DOE is needed to optimize the process for various MWC equipment configurations (such as modular and RDF stokers), to investigate and develop advanced reburn concepts, and to demonstrate the cost-effectiveness of these NO_x control techniques at full scale so that technology transfer can occur in the next 5 years.

6. Advanced Research & Technology Development (ARTD) ($6.0 Million)

The Advanced Research and Technology Development program generally supports basic research in combustion chemistry, engineering concepts, advanced process development, and materials and components that provide a technology base for ongoing fossil energy projects. Current research needs include: development of advanced high-temperature materials capable of resisting chemical attack from sodium and chlorine for application in glass and aluminum melting; development of inexpensive and durable catalysts to bring natural gas catalytic combustion closer to practical implementation; improving the understanding of the interaction of gasification catalysts with carbon/steam and carbon/hydrogen reactions; developing advanced processes for low-cost synthesized gas; developing lower-cost acid-gas cleanup processes; continuation of efforts to assess advanced cleanup technology for alkali metals, particulates and tars; and biological and catalytic production of high-value chemicals.

Transportation Fuel Alternatives and Emissions Solutions

1. Natural Gas Vehicles (NGVs) ($27.0 Million)

Development and utilization of vehicles powered by compressed natural gas would serve the national interest by helping to reduce reliance on less secure liquid fuels for transportation and by improving air quality. Natural gas is an abundant domestic fuel resource. It is also one of the cleanest fuels in its native form, requiring 15% less energy than gasoline for extraction and refining and 50% less energy than methanol manufactured from natural gas.

The emissions from natural gas vehicles (NGVs) have shown significant reductions in reactive hydrocarbons, carbon monoxide, and NO_x produced by gasoline-powered vehicles. Furthermore, unlike gasoline or diesel-powered vehicles, NGVs emit almost no sulfur oxides or particulate matter. Fleet use of NGVs in congested cities would provide a significant benefit to those areas where air quality improvement is most critical. There were over 59 such cities identified in the DOE Interim Report[14].

Moreover, the technology-forcing EPA particulate emissions standards effective in 1991 justify accelerated and focused development of advanced, dedicated natural gas-powered engines if heavy duty diesel engine users are to have a "clean" fuel vehicle alternative. The final Clean Air Act amendments will probably contain vehicle tailpipe emissions control requirements that mandate a 60 percent reduction in NO_x and 40 percent reduction in hydrocarbons by 1993. These amendments will most likely provide for further reductions after 2004 if EPA determines the air quality is in need of further improvement. Furthermore, within 5 to 7 years, fleet vehicles must use clean fuels.

Congress recognized the need for developing natural gas-powered heavy duty trucks and buses when it passed the Alternative Motor Fuels Act of 1988, which authorized $6 million for the development and demonstration of alternative-fueled trucks and buses. It also made available through the Department of Transportation's Urban Mass Transit Administration funding for the purchase by local mass transit authorities of alternative fuel buses that can meet the EPA 1991 emission standards.

As a direct result of research sponsored by the gas industry, heavy duty engines dedicated to natural gas use are becoming a reality mainly through the conversion of heavy duty vehicular diesel engine designs. Fundamental research is also being carried out on gasoline as well as diesel-derivative engines in a variety of sizes to acquire a thorough understanding of the intricacies of gaseous fuel injection, carburetion, manifolding, combustion, power optimization and emissions control so that natural gas can become broadly accepted as a transportation fuel.

Further accelerated research into novel gas compression concepts is required to advance the development of compressor technology that will facilitate the growth of the necessary natural gas refueling network. Research must also be conducted on advanced storage systems, such as sorbent materials, to increase the understanding of gas storage technology, particularly the fundamental principles of natural gas adsorption, absorption, clathration and catalysis. DOE funding of $10 million is recommended to cover these activities which will also be co-funded by the gas industry.

In addition, $15 million in DOE funding is also needed to conduct accelerated technology transfer on a variety of NGVs in many medium and heavy duty applications. To be most effective, such technology transfer activity requires that the government purchase and operate NGVs for its fleet. In addition, involvement of the major original equipment manufacturers (OEMs) is essential to the market success of natural gas vehicles. Such involvement is beginning to take place through co-funding with various utilities and GRI, and will contribute in FY 1992 the additional resources needed well in excess of the $15 million in DOE funds recommended here. This will provide the further impetus for RD&D activities leading to the widespread use of natural gas fleet vehicles in this country during the next 3 to 5 years.

Advanced propulsion concepts fueled by natural gas must also evolve as a partial solution to air emissions from the transportation sector. Low cost versions of aerospace-derivative fuel cells need to be developed for vehicular use. A promising concept is the use of solid polymer fuel cells to generate on-board power for propulsion. With initial DOE funding of $2 million, this research could lead to major improvements in power density over the phosphoric acid unit presently being tried in the fuel cell/battery bus program, partly sponsored by DOE.

Electrochemical Energy Conversion

1. Fuel Cells ($62.0 Million)

Natural gas-powered fuel cells convert the energy content of gas directly into electricity and by-product heat using a highly efficient electrochemical process. The electrical conversion efficiency of gas-powered fuel cells is approximately 15-20 percentage points greater than the conversion efficiency of traditional electrical generation[15]. For example, using molten carbonate fuel cells in power generation applications could achieve electrical efficiencies of 55 percent[16] compared to conversion efficiencies of 33 percent by conventional coal or gas-burning central station electric powerplants[17]. But more important is the fact that fuel cells are also environmentally benign, generating very little noise and vibration, and emitting virtually no pollutants.

Through DOE research assistance, this technology appears to be on the verge of becoming an important element in future energy conversion applications. Recently, a U.S. and a Japanese company have committed approximately $70 million to begin commercial production and marketing of 200 KW first generation (phosphoric acid) fuel cell powerplants.

To date, the gas and electric industries and DOE have jointly invested over $200 million in research and development of the phosphoric acid fuel cell system. To ensure this sizable investment brings the appropriate economic returns and environmental benefits, a vigorous national technology transfer program must follow. A continuing strong partnership between DOE and the industry is essential to such a program, to both provide the impetus for widespread initial deployment of fuel cells throughout this country, and to build a technology database for the next generation units.

The gas industry proposes that DOE operate a technology transfer program similar to the Alternative Motor Fuels Initiative. Under the proposed program, the federal government would draw upon a $9 million pool to offset the incremental cost to buy fuel cells over the $1,000/KW cost of conventional cogeneration packages. In this manner, both private and governmental entities would be aided in purchasing and testing units which, because of their incremental effect on the total number of orders, would be available at more competitive prices than would otherwise be possible.

RD&D funding is also required for the development of advanced fuel cells, which will operate at higher temperatures, allowing them to achieve even higher efficiencies and make them suitable for industrial applications. These second and third generation fuel cell concepts are still 5 and 10 years away from commercial use respectively, and therefore, are critically dependent upon continuity of federal RD&D support to supplement industry efforts.

Molten carbonate fuel cells (MCFC), which can achieve an overall electrical conversion efficiency of 55%, are targeted for introduction in the 250 KW size in 1995. A cost goal of $1,000/KW could be achieved if sufficient RD&D funding is obtained. Solid oxide fuel cells (SOFC), which operate at higher temperature and higher current densities than MCFC, can provide compact and highly efficient small power plants. However, because of its higher operating temperature, SOFC introduction requires considerable materials development, and therefore lags behind MCFC by about 5 years.

Because of the importance of these technologies, a total of $38.5 million should be used to support accelerated RD&D of MCFC, and $10.5 million should be used for accelerated and focused development of SOFC technologies. Furthermore, $2.0 million should be allocated for intensified development of solid polymer (proton exchange membrane) fuel cell technology. This is a promising new approach to the development of fast-response, compact fuel cells with low temperature heat rejection, suitable for electric power generation in stationary as well as mobile use. An additional $2.0 million should also be allocated to applied fuel cell research covering projects aimed at using solid polymer cell concepts in small-scale electric power generation, and projects that seek to improve the reliability and life of critical fuel cell components.

GAS SUPPLY

DOE's continuing involvement in gas supply research is essential to ensure the recovery of a larger percentage of the total domestic gas resource base. Our recommendation of $49.9 million for FY 1992 RD&D shows no increase above the industry's recommended FY 1991 funding levels and is predicated on the continuation of the gas supply research programs recommended for FY 1991.

Estimated consumption of natural gas in 1989 was 19.4 quads. Current domestic production is running at about 17.6 quads annually with the balance of demand met by other sources such as, storage, supplemental gaseous fuels and natural gas imports. The critical question is whether the capability exists for additional domestic production at competitive prices to meet projected increased demand.

A recent Department of Energy study *18* shows that a technically recoverable resource base of 1,059 trillion cubic feet (Tcf) of natural gas exists in the lower-48 states. At the 1989 level of nationwide gas consumption, this amount is approximately equivalent to a 54-year supply.

The amount of gas that can be recovered from the total gas resource base is directly contingent upon the ability to develop new tools and techniques to recover this gas at commercially viable prices. This resource base is made up of reserves and resources. The recovery of gas in the "resources" category requires discovery and development of new technology on the basis of an improved understanding of reservoir geometry. Of the total resource evaluated in the lower-48 states 583 Tcf is judged economically recoverable at 1987 wellhead prices of less than $3/Mcf. An additional 174 Tcf of gas is judged economically recoverable in a price range of $3 to $5/Mcf.

It is clear from the above DOE study that there is no gas resource limitation that would preclude an expanded role for gas in the U.S. energy economy. The uncertainties of gas deliverability are not resource limitations. Rather, they are the pace of technological innovation and of new investment that will be necessary to sustain the levels of gas production needed in the future to meet increased demand resulting from environmental concerns. What remains to be developed are concepts for recovering conventional and unconventional gas at competitive prices.

Moreover, because of the potentially enormous size of advanced unconventional natural gas resources such as deep source gas reservoirs and secondary recovery techniques, extensive research is needed to both verify how much may be economically recoverable and to develop the requisite technology. Simply stated, early research and development efforts in the area of deep source gas, subquality gas upgrading and secondary gas recovery (such as coproduction and inert gas sweep) will help define the scope of the resource. Continuing federally sponsored research is necessary to encourage such exploration and to lower production costs, providing increased assurance that plenty of gas will continue to be available at competitive prices for several hundred years into the future.

Specific Supply RD&D Recommendations

Technology can make a difference in the cost of production of gas from the resource base. The gas resource base accessible to U.S. gas users under current industry practices generally reflects the historical perceptions since the 1970's of that resource base. Under then **current practice**, U.S. gas production was sustained primarily by the discovery of new high-permeability fields and reserve appreciation in known fields using traditional development practices. Less conventional sources, such as Devonian shale, tight sands, and coalbed methane played a very minor role in industry activity. These sources were then considered to require very high energy prices and/or new technology to ensure their viability.

In the 1980's **new initiatives** began to expand the perception of the gas resource base available to the U.S. gas user. New technologies and practices developed in the 1980's or expected in the future indicate that less conventional gas sources can play a substantial role in future gas supply, even without high prices.

A 1989 GRI Baseline Projection covering 20 years showed current practice supply declining through the projection period as old fields are depleted *19*. The increased gas supply in the projection arises from the growing role of new initiatives in the U.S. gas supply picture. For example, the incremental lower-48 gas production resulting from advanced technology is projected to provide 14 percent of U.S. gas supply by 2000 and 23 percent by 2010. The advanced technology production is from Devonian shale, tight sands, coal seams, and watered-out reservoirs.

This advanced technology production does not include any contribution from improved gas recovery from high-permeability gas reservoirs using more intensive in-field drilling or from geopressured reservoirs. A recent DOE gas resource study indicated that, with existing technology, the resource is estimated at 56 Tcf recoverable at $3/Mcf and 74 Tcf recoverable at $5/Mcf.

Coalbed methane and low-permeability production are expected to grow substantially over the 20-year projection period, with more of the growth occurring by the year 2000. Devonian shale gas production will also increase substantially after the year 2000. The growth in all these resource categories is contingent upon the availability of advanced technology.

The contribution of advanced technology production in turn will depend on the pace at which the predictability and reliability of new production techniques can be demonstrated and brought into widespread use. These advanced technologies will need to become available in the early-1990s. This can be achieved only through an expanded and directed near-term supply R&D program sponsored by DOE in cooperation with the gas industry.

It is clear that advanced gas well completion and production technology will be a major factor if the United States is to solve some of its near-term environmental problems through an expanded role for natural gas. What is needed is an aggressive federal/gas industry joint R&D effort during the next ten years. This effort should include continued research on production of natural gas from geopressured resources, and synthetic gas from biofuels and coal. As described in the following, these technologies could provide additional supplies of gas in the 2010 timeframe.

1. Unconventional Natural Gas ($23.8 Million)

Large amounts of natural gas have been identified in tight geological formations such as Devonian shales and tight sands, which have been estimated to contain more than 1,800 Tcf and 900 Tcf of natural gas, respectively[18]. Tight formation gas is produced using advanced recovery techniques such as hydraulic fracturing. A.G.A. estimates that favorable economic conditions and substantial investment in advanced recovery techniques could increase the accessible gas resources and improve the economics of gas production[20]

Basic geoscience research must be expanded to maximize the amount of natural gas recovered from our abundant resource base. This research should be aimed at increasing our knowledge of the geological, geochemical and geophysical characteristics and parameters of both conventional and unconventional formations. This cross-cutting, reservoir characterization-type research is essential to both exploration and production in new formations, which are characterized by subtle traps. It is also essential to the application of secondary recovery techniques in existing fields.

To enhance the development of technology necessary to recover the natural gas from unconventional formations, more research must also be conducted to develop stimulation techniques to fracture tight rock formations that restrict gas flow. Current fracturing techniques induce only shallow fractures of a few hundred feet. Field testing must be conducted to refine techniques for inducing deep fractures of several thousand feet and to control the direction of the fracture for optimal production results. Research information must be collected from field testing to establish a technological database for stimulation, economic modeling and other analytical purposes.

In addition, advanced drilling techniques (directional and horizontal) must be refined and improved to increase production rates and reduce drilling costs. Funding of $23.8 million in the unconventional natural gas recovery program is recommended to continue DOE's secondary gas recovery program and ongoing research activities in western tight sands, Devonian shales, and other complex formations. This funding level will also support expanded geoscience research.

2. Surface Coal Gasification ($8.5 Million)
Surface coal gasification is an important technology that can augment future natural gas supplies. Based on anticipated economics, A.G.A. projects that, by the year 2010, surface coal gasification has the potential to contribute approximately 100 billion cubic feet (Bcf) of additional gas supplies. With vigorous RD&D support, this economic threshold could be lowered. Surface coal gasification could then increase this level of production, thus enhancing the domestic gas production capability*20*.

Current technologies allow significant production of gas from coal; however, substantial research into the gasification process is necessary if gas synthesized from coal is to play a role in meeting this nation's future energy needs. Gasification techniques must be developed to accommodate high-sulfur Eastern coals and combustion-inhibiting coal "fines". Research must be conducted to develop techniques for gasifying the fines, for treatment and disposal of liquid byproducts, and for consolidating fines and tars into a useful byproduct. Further scaleup of mild gasification is also needed before this technology can be put to full use.

Scientific and engineering feasibility studies of advanced gasification processes must also be conducted to develop a technological database for such processes.

3. Geopressured Methane ($9.6 Million)
Geopressured methane is found in either a free state or dissolved in water and trapped in sedimentary rock at higher-than-normal pressures. One of the largest geopressured areas underlies a portion of the Texas and Louisiana Gulf Coast. Estimates of the total resource in-place range up to 6,000 Tcf; however, estimates of the amounts of gas that might ultimately be recovered using current recovery techniques, range between 10 and 150 Tcf*18*. If technological breakthroughs can be achieved, geopressured methane could become another major source of domestic energy.

Research currently conducted by DOE in geopressured/geothermal zones is focused on reservoir science, recovering gas and producing electricity from heat available in the reservoir brine. DOE research should concentrate on improved understanding of the scientific aspects of reservoir modeling and production dynamics and on recovering the vast amount of dissolved methane found in geopressured zones. In addition to DOE's current geopressured program, DOE should develop new approaches to maximize gas production and minimize brine production.

4. Biofuels ($8.0 Million)
Since the supply of biomass and waste materials is virtually limitless, supplemental methane supplies from biomass and waste conversions can add significantly to the total future gas supply. In addition, controlled production and use of methane from these sources can reduce natural release of methane from the decay of

these waste materials. Such decay is a substantial contributor to the overall rate of methane emissions to the atmosphere. Finding sites for disposal of municipal solid waste is an increasing problem in communities across the nation. Therefore, developing energy from municipal solid waste and other biomass would promote the conservation of resources and derive environmental benefits arising from productive use of currently "useless" materials. Presently, the quality of the gas produced and the lack of suitable processing techniques inhibit the widespread use of these potential gas resources.

The gas industry fully supports the gas-related biofuels RD&D being carried out at the Solar Energy Research Institute (SERI) and recommends strong federal support for continuation of these important activities. Advances have been made in both the thermochemical and biochemical conversion processes, but more extensive studies and technology advancements are necessary to fulfill biomass' contribution as a usable source of energy.

Of particular interest to the gas industry is SERI's work in the biotechnology process of anaerobic digestion of municipal solid waste that includes genetic and other improvement of biological organisms and development of innovative reactor design concepts. Another significant area of research at SERI includes methods to remove carbon dioxide from the air or from combustion plant stacks.

Another area of interest to the gas industry is the research conducted by IGT on advanced biological and thermal gasification of municipal solid waste both in landfills and above ground reactors.

A total of $8.0 million is needed to perform these gas supply-related RD&D activities in FY 1992. Of this, $4.0 million should be dedicated to funding SERI activities. Strong, stable funding levels from DOE for all biofuels research work at SERI will help ensure successful results.

CONCLUSIONS

The natural gas industry recognizes that greater energy security, improved air quality and energy efficiency are essential to a strong U.S. economy and competitive edge. The recommendation for a total amount of $215 million for gas utilization and supply RD&D in Fiscal Year 1992 is required because of the increasing urgency to promote efficient end-use technologies and conservation measures that help meet more ambitious environmental objectives than in the past.

The gas industry recommendation requests funding only for those technologies that are essential and prudent for the orderly development of advanced and new gas utilization and supply methods and processes. With the focus of the Administration, Congress and the public on energy efficiency and clean air, there is a growing consensus that natural gas has an increasing role to play in our nation's energy security and environmental quality. To make this a reality, there must be increased focus on federal funding for research and development of technologies that utilize this gas more efficiently while minimizing emissions into the atmosphere and at the same time assuring its continued availability.

Meeting these challenges will require careful planning for energy usage in the future. That is why the gas industry is actively providing inputs into both a national energy strategy plan and the DOE yearly budget. We believe that a necessary component of this planning effort must include a re-examination of DOE funding for energy utilization technology research and development. Additional levels of funding to develop new low emission and fuel-efficient energy technologies will be necessary to satisfy pressing air quality concerns. Therefore, in developing a sound national energy strategy, DOE must provide natural gas-related R&D a much larger presence in its FY 1992 budget.

The near and long-term benefits of technology breakthroughs resulting from this research will have wide application throughout the country. The nation will not only achieve improved air quality and ensure the health and well-being of its citizens, but it will also promote the efficient use of its energy resources. In so doing, the energy security of the nation will be enhanced while enabling U.S. industry to better compete in the global marketplace as a leader in emissions reduction, new vehicle technologies and advanced energy conversion methods.

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Attachment A
DOE FY 1991 & 1992 Gas-Related Budget
Major Gas-Related Emissions/Efficiency Utilization and Supply Research Programs
($ Millions)

	FY 1990 DOE Request	FY 1990 Gas Industry Recomm	FY 1990 Congress Appropr	FY 1991 DOE Request	FY 1991 Gas Industry Recomm	FY 1992 Gas Industry Recomm
Stationary Emissions/Efficiency						
Combustion--System/Emiss. Cont.	0.0	2.0	0.0	0.0	0.5	17.8
Conservation (Cooling & Industrial Processes)	10.2	29.5	25.4	17.8	16.8	36.8
Heat Engines	0.0	8.0	0.0	0.0	2.9	6.9
Coal & Waste Cofiring/Reburn	N/A	N/A	2.5	0.0	8.5	8.5
ARTD	3.0	6.0	4.7	3.9	6.0	6.0
Transp. Fuel/Emissions Solutions						
Natural Gas Vehicles	0.7	9.5	2.5	4.0	10.6	27.0
Electrochemical Energy Conversion						
Fuel Cells	6.5	36.5	30.1	7.1	40.5	62.0
Subtotal	**20.4**	**91.5**	**65.2**	**32.8**	**85.8**	**165.0**
Gas Supply Enhancement						
Unconventional Natural Gas	4.1	15.0	14.6	13.7	23.3	23.8
Surface Coal Gasification	8.7	3.4	23.7	8.5	8.5	8.5
Geopressured Resources	2.9	8.4	6.0	2.9	9.6	9.6
Biofuels	4.5	5.0	8.6	2.5	8.0	8.0
Underground Coal Gasification	0.4	2.5	0.8	0.5	0.5	0.0
Geosciences	3.0	—*	4.0	4.5	—*	—*
Subtotal	**23.6**	**34.3**	**57.7**	**32.6**	**49.9**	**49.9**
TOTAL	**$44.0**	**$125.8**	**$122.9**	**$65.4**	**$135.7**	**$214.9**

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* While the gas industry is supporting geosciences as a concept, it is not supporting a specific line-item funding level. The industry is, however, supporting a funding level of $10 million for gas related geoscience work that is included in other line items, e.g., Advanced Extraction and Process Technology and Unconventional Natural Gas.

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Statement
of the
AMERICAN PUBLIC POWER ASSOCIATION
Submitted to the
SUBCOMMITTEE ON THE ENVIRONMENT
HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
on the
DEPARTMENT OF ENERGY CONSERVATION PROGRAM

April 17, 1991

APPA is the national service organization representing more than 1,750 local, publicly owned electric utility systems. APPA appreciates the invitation to submit written testimony to this subcommittee on the Department of Energy's conservation program. APPA's comments, as requested, will focus on the Department's electric and magnetic fields (EMF) research program.

As consumer-owned utilities, providing reliable, affordable, and safe electric power to our customers has been, and will continue to be, the primary objectives of public power systems. The lights must go on when the switch is flipped; electric bills must be reasonable for all customers; and the public must be confident that its health is not being threatened by electric power generation or distribution. Because public power officials work and live in the communities they serve, they are deeply interested in ensuring that these objectives are met for their customer-owners.

The electric utility industry has done much to shed light on EMF. Since the early 1970s, the Electric Power Research Institute (EPRI), with funding from public and private utilities, has sponsored research into possible health effects of EMF. In 1990, EPRI contributed approximately $6 million toward EMF research. This figure accounts for almost 40 percent of the worldwide effort to understand electric and magnetic fields.

However, a strong federal presence in EMF research is needed to complement the research currently being done by the industry. Public concern and media attention about the possible adverse health effects of electric and magnetic fields associated with delivery of electric services and the use of electric equipment and appliances have increased to the point that existing research efforts should be stepped up in order to produce credible results more quickly.

Early studies – focusing on the electric fields generated around high-voltage electrical facilities – showed little, if any, relationship between electric fields and adverse health effects. But some more recent studies have suggested a possible link between magnetic fields and cancer. The areas on which scientific and public concern have been focused are neurophysiology, reproductive disorders, and abnormal cell growth – particularly childhood leukemia and brain tumors. Several relevant epidemiological studies have yielded positive results (e.g., showing a relationship), although generally with very low risk factors. During the last decade, research by DOE on humans, animals, tissues, and cells has shown that there is an interaction between biological systems and 60 Hz electric and magnetic fields, but the health effect of this interaction has yet to be determined.

When the Department of Energy research program began a decade ago, EMF science was in its infancy. Little, if anything, was known as to even where to begin to ask the proper scientific questions on adverse health effects from EMF exposure. EMF science was then, and still is, one of the most complex and difficult areas of scientific inquiry.

The last several years have seen important original discoveries result from the DOE-funded program, including changes in calcium uptake at cell membranes, changes in levels of the human hormone melatonin, changes in human sleep patterns known as circadian rhythms, and the "windows effect." The first three of these discoveries are now providing defined paths to begin focusing further scientific study on how adverse health effects may be promoted by EMF exposure.

The fourth DOE-funded discovery, the "windows effect," is in the area of exposure assessment and may have important public policy implications. The windows effect, observed both at the cellular and human level, suggests that there may be a certain band of magnetic field exposure levels in which higher levels are actually more benign than lower levels. If further studies confirm this theory, then exposure standards that assume the classic "more is worse" of an environmental agent may not be prudent.

These discoveries funded by DOE are now providing some direction to scientists in narrowing the search for how adverse health effects may occur. While epidemiology may help answer the question of whether there are adverse health effects from EMF exposure, only basic laboratory science such as that funded by DOE can answer how EMF actually causes the adverse health effect. Such an understanding is necessary to answer the broader policy questions.

Because of the importance of this work to the public, APPA continues to support an increased research effort by DOE in the area of biological effects of EMF. The Department's Office of Energy Management should be credited with raising the priority of EMF on both a national and international basis, and it is our belief that funding for EMF research should remain within the jurisdiction of that department of DOE. It is extremely important to ensure the continuity and continuation of DOE's EMF research program.

The present DOE research should be extended to establish closer limits on relevant exposure parameters, utilizing human, animal, and cellular work. Studies should also be initiated to analyze the effect of field exposure on brain tumor growth, explore melatonin mechanisms, and carry out experiments on skin tumors and sleep disorders. In addition, there should be a major push toward determining the dose/effect relationship for biological effects. Additional funding is needed to expand the scope of DOE's current EMF research program, and we commend the Administration for requesting $5 million for FY 1992. This is certainly a step in the right direction toward increasing the federal government's commitment in this area of research.

APPA has supported increased federal funding for EMF research by the Department of Energy for a number of years. For that reason, APPA endorses Representative Frank Pallone's legislation, H.R. 1483, to establish a centralized EMF research program at DOE. We agree that DOE should receive larger and predictable funding for its ongoing EMF research and that enactment of a comprehensive federal EMF research program will ensure that this important issue continues to be addressed. Coordination of existing research efforts will prevent duplication and ensure that high caliber research is conducted. We also agree with Congressman Pallone that input from an advisory committee composed of scientists and representatives from government, industry, and environmental organizations will be of value in recommending priorities and direction for new research.

APPA would suggest, however, that DOE expertise be limited to specific areas of science and that other federal agencies have a contribution to make in other areas of research. For example, an additional source of federal research support should be developed through the National Institutes of Health (NIH). NIH leads the federal government in health research, is renowned for its expertise and skills in conducting epidemiological studies, and should be the government's leading epidemiological investigator. In addition, the National Institute of Environmental Health Sciences and the National Cancer Institute at NIH should be encouraged to pursue work in comprehensive animal studies and childhood leukemia, respectively.

The Environmental Protection Agency (EPA) also has a role to play in this issue. Although EPA does not have the ability to conduct its own basic research on health effects of EMF, the Office of Air and Radiation has renewed its activities on EMF. A draft report evaluating the status of existing EMF scientific data recently released by EPA will be an extremely useful tool in determining where the research should go from here. EPA has a proven ability to disseminate information on important environmental risk issues, such as radon and asbestos, and should continue to play a role in consumer information. Finally, EPA also has the ability to contribute to ongoing studies which need additional financial support. APPA believes EPA should be a participant in the EMF issue.

Despite the increased willingness of the federal government to participate in EMF research, serious financial constraints exist on the federal budget. A number of new endeavors undertaken by the federal government, particularly in the areas of research and development, require a collaborative industry/government effort. APPA believes that limited federal EMF research dollars could be leveraged by supplemental funding from nonfederal sources.

The members of APPA are willing to do their part toward answering the many questions about EMF. While public power systems are providing their customers with all the information available about EMF, they still cannot answer the most important and most asked question: "Is EMF harmful to human health?"

In a resolution approved by APPA's policy committee in March, and attached to this testimony, our members agreed that more must be done. Specifically, APPA's resolution calls for continued support for existing federal EMF programs and enactment of a supplementary research program funded equally by federal and voluntary nonfederal contributions. Nonfederal entities such as electric utilities, manufacturers of appliances and electrical equipment, computer manufacturers, labor unions, and consumer groups are interested in making a financial contribution to a research effort on EMF. An independent research institution with a demonstrated ability to conduct health-related research should be selected to conduct this supplementary research. APPA's primary goal is to provide the public with an unbiased scientific evaluation of any potential health hazard. We believe this subcommittee should consider authorizing such an expanded and sustained EMF research effort.

Considering the time it takes to design properly and carry out experiments, it takes years to develop a good EMF research program. This is particularly true of EMF research which involves extremely complex science and where the number of qualified researchers is small. An ongoing, sustained research program is necessary to allow results to develop so that adequate information is available for sound public policy decisions.

APPA appreciates the interest this subcommittee has shown in the debate over the possible health effects of electric and magnetic fields. We also commend the Department of Energy for its efforts and urge that this issue receive high priority treatment. APPA urges the Department of Energy to provide sufficient funding for the EMF research program in order to ensure timely research results.

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ELECTRIC AND MAGNETIC FIELDS NATIONAL STRATEGY

Increasing public attention and concern about possible adverse health effects from electric and magnetic fields (EMF) has created pressure on state legislatures, governmental agencies, utility commissions and Congress to act to reduce perceived risks.

While some scientific studies have suggested a possible link between exposure to electric and magnetic fields and adverse health effects other studies have suggested no adverse health effects or have been inconclusive. Such inconclusive and often contradictory results make it apparent that the science has not advanced to the point necessary to provide a sufficient basis for decision-making on this issue.

Both the federal government and the Electric Power Research Institute (EPRI) are conducting in depth research on possible health effects of EMF. These efforts must be maintained. However, an expanded and accelerated national EMF research program to supplement the present activities of both the federal government and EPRI is needed. This expanded and sustained research effort should be funded equally by federal and voluntary non-federal contributions with all funds being administered by a highly respected independent research institution that has a proven ability to conduct health-related research.

Collectively, the results of research from the federal government, EPRI, and the proposed joint federal and non-federal program will provide a stronger scientific basis for informed decision making by public officials, other concerned organizations and the public at large, and will permit the development of a responsible public policy that recognizes and balances the benefits of electricity and the risks, if any, of electric and magnetic fields.

In addition, a national strategy on EMF for electric utilities and their trade associations must encompass information dissemination as well as employee and customer education efforts. Both activities are important to ensure that policy makers and the public have access to all relevant information on EMF.

NOW, THEREFORE, BE IT RESOLVED: that the American Public Power Association supports a national strategy to address and resolve the questions regarding the health effects, if any, of electric and magnetic fields (EMF), consisting of the following elements:

1. An aggressive Congressional campaign to ensure sufficient federal funds to (a) launch and successfully complete an EMF national research

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program and (b) continue support for existing federal EMF programs that meet objectives set for them by Congress and the scientific community.

2. The EMF national research program shall be equally funded through federal appropriations and voluntary contributions from non-federal entities such as electric utilities, manufacturers of appliances and electrical equipment, computer manufacturers, labor unions, consumer groups and other organizations, with funds administered by an independent research institution;

3. A continued and more aggressive program to collect and disseminate information on EMF to all APPA members; and

4. The preparation of materials to assist APPA members in educating their employees and their consumers regarding EMF, including the development of model policies and protocols for responding to customer requests for EMF measurements, and

AND BE IT FURTHER RESOLVED: that the Legislative and Resolutions Committee urges the APPA EMF Task Force to consider other activities that might be incorporated in this national EMF strategy and to report on the results of its deliberations at the next Legislative and Resolutions Committee meeting.

Adopted by the Legislative and Resolutions Committee of the American Public Power Association, March 11, 1991.

9

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April 19, 1991

The Honorable James H. Scheuer
Chairman
Subcommittee on Environment
Committee on Science, Space,
and Technology
U.S. House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

The development and application of technology, particularly technology related to the generation and distribution of electrical energy, are particular interests of the Institute of Electrical and Electronics Engineers - United States Activities (IEEE-USA) and its Energy Policy Committee. The IEEE-USA is the world's largest technical professional society with nearly a quarter of a million members in the United States engaged in advancing the frontiers of knowledge and sustaining our technological competitiveness with a broad and growing range of electrotechnologies.

We are therefore pleased to outline our views on the FY 1992 budget request for energy efficiency/conservation programs of the Department of Energy, and ask that our statement be made part of the record of the subcommittee's April 17th hearing.

Energy is important to the nation's economic growth, national security, and international competitiveness. Of chief concern are the reliability and continuity of the nation's electricity supply system and the related environmental issues associated with electric power production. The IEEE-USA's Energy Policy Committee strongly supports DOE funded research which addresses these concerns. We particularly support research related to improved energy efficiency.

The IEEE-USA Energy Policy Committee believes that energy efficiency is a necessary component of a comprehensive national energy policy designed to ensure an adequate and economical energy supply. We are pleased to see the significant increase in DOE's funding request for improved energy efficiency in the utility, building, industrial and transportation sectors. We hope this continues to be the case. In addition, we strongly support Federal and state initiatives for demand side management. We will focus the balance of our comments on DOE programs in the building and industrial sector.

IEEE-USA, 1828 L Street, N.W. Suite 1202, Washington, DC 20036-5104
The Institute of Electrical and Electronics Engineers, Inc.

Building Sector

The increase in funding for the building sector is welcome and endorsed by the IEEE-USA Energy Policy Committee. Planned research activities are important and necessary. However, we believe three areas in the building sector need new or increased emphasis: code enforcement, commercial building ventilation, and technology transfer. Rules, regulations, codes, and standards to improve efficiency in energy use in the building sector are of course important and necessary. But, at present, enforcement is limited or lacking. We believe DOE should examine this situation and, if required, provide adequate funding to the States to enhance enforcement programs.

Commercial building ventilation needs special attention. Standards developers and code makers are increasing ventilation requirements to improve indoor air quality without assessing their impact on energy consumption. There exists a large potential for reduction in energy consumption, if ventilation requirements are established that integrate the goals of indoor air quality and improved efficiency. Funding targeted to this area is vital.

In previous testimony, we have highlighted the need to improve technology transfer. This need still exists and will increase over time. Building developers are in too many instances limiting their investment in new and improved designs in order to conserve scarce capital. As a consequence, architects and engineers do not have the resources to assess and optimize building designs to increase efficiency. Enhancing technology transfer in the building sector can have a significant impact on improved efficiency since buildings live and consume energy for 40 to 50 years.

Industrial Sector

The IEEE-USA Energy Policy Committee strongly supports increased funding to improve energy efficiency in the industrial sector. However, we believe that emphasis should be placed also on increasing the use of high efficiency motors in the industrial sector. This could be accomplished by demand-side management programs, legislative requirements, tax credits, or an energy consumption tax on standard motors. Regular use of high efficiency motors can produce a significant increase in energy efficiency.

Conclusion

We appreciate your consideration of our views. The IEEE-USA and its Energy Policy Committee stand ready to assist you as a resource for technical advice and policy perspectives on DOE's important energy efficiency/conservation programs.

Sincerely,

M. J. Whitelaw

Michael J. Whitelaw
Vice President
Professional Activities

and

Chairman
U.S. Activities Board

The American Society of
Mechanical Engineers

Suite 218
1825 K Street, N.W.
Washington, DC 20006-1202
202-785-3756

May 3, 1991

Hon. James H. Scheuer
Chairman
Subcommittee on Environment
Committee on Science, Space and Technology
U.S. House of Representatives
388 Ford House Office Building
Washington, D.C. 20515

Attention: Eileen Lee

Dear Mr. Chairman:

The enclosed statement prepared by a Task Force of the ASME Solar Energy Division is submitted for inclusion in the record of the subcommittee's 4/17/91 hearing on the Department of Energy's FY 1992 budget request for energy conservation programs. We hope that the subcommittee will find the information and recommendations presented in the statement of value in your deliberations on these important programs.

We are grateful to you and the subcommittee for providing the ASME the opportunity to present our views. Should you or your staff require any additional information or assistance, please let me know.

Sincerely,

Nelson L. Milder
Assistant Director
Policy Development and Technical Support
Government Relations

The American Society of
Mechanical Engineers

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Washington, DC 20006-1202
202-785-3756

Statement of the

Energy Conservation Task Force of the

Solar Energy Division of the

American Society of Mechanical Engineers

on the

Department of Energy Fiscal Year 1992

Congressional Budget Request for

Energy Conservation

Submitted to the Subcommittee on the Environment of the

Committee on Science, Space and Technology

U.S. House of Representatives

May 3, 1991

The Energy Conservation Task Force of the Solar Energy Division of the American Society of Mechanical Engineers (ASME), welcomes the opportunity to provide its views on the Congressional Budget Request of the Department of Energy for FY 1992. A list of the members of the Energy Conservation Task Force is provided in the Appendix.

The ASME, established in 1880, is a worldwide engineering society focused on technical, educational, and research issues, with 118,000 members, including 21,000 students. ASME serves its members, industry, and government by encouraging the development of new technologies, while helping to solve the problems of an increasingly technological society.

The ASME Solar Energy Division (SED) is now in its 34th year of service, having been founded in 1956. Our national and international conferences have enabled the exchange of data, ideas, and information about alternative energy methods, processes, and results. For instance, over 100 engineers participated in our 13th International Solar Energy Conference in Reno, Nevada, March 17-20, 1991, which was jointly sponsored by ASME, the Japanese Solar Energy Society and the Japanese Society of Mechanical Engineers. In addition to papers on solar energy system innovations, papers were presented on a number of the topics related to the DOE Energy Conservation Budget. In particular papers were presented on: energy conservation in buildings, testing and measurements, indoor air quality, solar powered cars, and the use of solar energy for the destruction of hazardous waste.

General Comments on the FY 1992 Budget for Energy Conservation

The President's FY 1992 Budget Request proposes cuts in the DOE Energy Conservation programs from $495 million in FY 1991 to $326 million or to 66% of the FY 1991 funding. We do not support this reduction. We believe that now is the time to increase rather than reduce efforts in developing and demonstrating improved energy conservation technologies.

We support an increase of funds for the conservation activities in the buildings, industry, transportation, and utility sectors of the Energy Conservation Budget. The proposed 27% increase of funds for these sectors from their FY 1991 Budget is an overly modest increase.

We oppose the extremely sharp cuts in funding for technical and financial assistance programs. The FY 92 budget provides only 17.5% of FY 1991 budgeted funds for these programs. State governments, strapped by more pressing problems and caught in a recessionary spiral, have little ability to provide technical and financial assistance. The state energy office programs of the 1970's and early 1980's have been reorganized and their influence and programs have all but disappeared, due to reduced funding priorities.

It appears that current market indicators of lower domestic petroleum prices and the public's purchasing of automobiles with less-conserving and higher-performance engines, have been used to justify the proposed overall reduction in conservation funding. Such short-term market features do not support a sustainable energy future.

The National Energy Strategy projects considerably increased energy conservation activities in order to meet the future national requirements. In the past decade, energy conservation made a very significant contribution to reduced energy demand. However, we doubt that the proposed funding will be adequate to develop the technology base and overcome enough market barriers to meet its projected reduction in national energy demand.

In addition, the societal and environmental benefits of energy conservation and the use of renewable energy technologies need to be given proper economic consideration. These externalities, which are now being defined in utility sector applications, need to be incorporated into the decision-making process for commercial enterprises. The federal government should take the lead by implementing programs that account for these real societal and environmental costs.

Conservation Activities in the Building Sector

We support the development of the technological base for energy conservation. We particularly endorse the expanded funding of the Buildings sector in their programs for Building Systems (standards) and Energy Efficient Mortgages. However, we are skeptical that the goal of reducing building energy loads in new buildings by 30% in the near-term, 55% in the mid-term, and 80% in the long-term can be met without a more realistic funding posture. The federal government should increase its support of energy research and provide incentives to private industry and governmental agencies.

Although not fully implemented, actions related to the Federal Building Energy Performance Standards (BEPS) program (since 1975) have been the impetus for dramatic changes in the way buildings are designed. The impact of this program has been enormous, a highly effective expenditure of federal funds.

Architects, engineers, builders and owners must be ultimately influenced if energy consumption in buildings is to be significantly reduced. The forces of our free market system cause architects and consulting engineers to utilize those design tools which are most convenient and least costly. Given a fixed-fee for design, the designers tend not to experiment with a current project, but rather to rely on the research and development (R&D) that has already taken place. Designers are using the tools from the 1970's, rather than the 1980's because the R&D effort has been minimal.

We believe that the activities in: materials and structure, heating and cooling equipment, and indoor air quality are important and should receive additional support over the proposed level funding. Indoor air quality, ventilation, and infiltration in buildings require significant work to improve the health, safety, and energy efficiency of buildings. Health problems associated with poor HVAC systems and buildings that are too tightly sealed have become a major concern. The health effects issues have not generally been addressed by the free market, except in a limited number of cases. Studies are also needed to measure the air quality benefits associated with increased productivity of occupants.

The building sector's solar technologies program is proposed to receive reduced funding. This is not consistent with either the short-term or long-term goals of developing cost-effective solar technologies to provide 25% and 50% respectively, of the energy requirements for new buildings. Increased funding is warranted in this area to help reach these goals.

Energy consumption reductions in commercial buildings have been impressive during the last decade. However, the increase of over one quad of consumption, experienced during the past year, is cause for concern that compels continued research into improving building energy efficiency. A number of items are particularly important:

1. Windows are the single largest building envelope heat loss path. Window sizes have been reduced to meet energy codes, and window performance has been improved. However, there is only so much that can be done with currently available commercial windows. Continued research is needed to produce economical, low heat loss windows with the goal of a heat loss R-value of around 10. Past research has made significant progress toward this goal. Products meeting this goal would be expected to have considerable potential for marketing success overseas.

2. Daylighting is the least used renewable resource in buildings. For commercial buildings, daylighting is the most effective way to reduce energy consumption. Electrical energy savings could result from both reduced conventional lighting and the corresponding cooling loads. Research is needed to develop methods for the efficient transport of daylight into the interior of commercial buildings. Recent research in Japan and the US indicates that fiber optics and reflective surfaces can be used to bring daylight into buildings interiors more economically than the use of atriums. We support continued research in daylighting.

3. Testing of commercial buildings can lead to better diagnosis of energy usage profiles and to corrective actions, which reduce both operating costs and energy consumption. However, testing of commercial buildings is generally not included in construction budgets. It is always assumed by the plan reviewing authority that the building will perform according to the code. However, this is rarely the case, due to lack of care, knowledge and poor workmanship. The costs for testing must be planned into the energy budget of a building.

With adequate research, new and improved control system strategies can be developed, which would result in major reductions in energy consumption. These could make use of the resources of adaptive control, artificial intelligence, and real time optimization techniques.

Concerning the Federal Energy Management program, we support plans for federal participation in utility demand-side programs and the development of support systems for federal facility managers to assess systems performance.

We are encouraged by the recent Presidential Executive Order on energy management in federal buildings and transportation systems. The federal government is a major operator of commercial buildings, many of which have poor records in energy conservation. We believe that the federal government, which is the nation's largest energy consumer at $9 billion/year, should serve as an important role model, leading the way in energy conservation and implementation of renewable energy systems.

The DOE monitoring of selected federal buildings for retrofit is important. The results can include an evaluation of which energy conservation measures are the most cost effective, and the dissemination of this information to the building community. For example, reports of the very significant and cost-effective efforts (which have saved 50-100 times the implementation costs since 1986) in the Forrestal Building and the DOE Germantown Complex provide an indication of the considerable benefits of an integrated monitoring system with proper technology transfer between engineering and operating personnel.

Revolving loan programs, such as those developed by the LoanSTAR program in Texas, have demonstrated the potential to achieve a much greater level of savings per dollar spent than grant programs. Capital funds obtained through revolving loan programs are being repaid using the return from reduced energy costs. Their costs are primarily for interest and administrative expenses. These programs need operating guidelines. For instance a feature of the Texas program requires monitoring of building operations. This has helped identify areas for additional energy savings that would not have occurred without monitoring. These may be particularly appropriate for governmental buildings and public institutions such as schools and hospitals.

Technical and Financial Assistance Programs

The FY 1992 DOE Budget proposes funding for technical and financial assistance programs at only 17.5% of the 1991 funding level. In particular no DOE funds are planned for the state and local assistance programs. This will effectively shut-down many of the state technical and financial assistance programs. State programs have been supported through a combination of funds from DOE, the Petroleum Overcharge Distribution and Restitution Act (PODRA) and state governments. Although some states may have substantial PODRA funds, in many states, these programs have very limited funds available for the future.

State and local technical and financial assistance programs have enabled significant energy conservation, which otherwise would not have occurred. For instance, the Weatherization Assistance Programs have funded conservation repairs and retrofits for houses of low income and elderly persons. We feel that state technical and financial assistance programs are essential to achieving the future buildings sector conservation goals of DOE.

Major efforts have been conducted to assure state assistance programs are effective in delivering cost-effective services. For instance the Virginia program has reported a testing pilot study, which shows that new measures of retrofit will result in an average fuel savings of 28% for site-built houses and 17% for manufactures houses. Less effective conservation schemes have been eliminated; and new measures are being adopted, such as the use of dense-pack sidewall insulation and proper furnace inspection/service.

The DOE budget needs to continue to support and enhance the National Evaluation and Weatherization programs, which began in 1990. The program envisions various phases of activities, which are projected to be completed in FY 1993. The program should be expanded to include measurement and analysis to provide the basis for policy decisions, which focus on the use of funds for the most cost-effective applications.

Utility Sector Programs

We support the Integrated Resource Planning (IRP) program of the Office of Energy Management. The objective includes the encouragement of creative economic measures in utility decision making. For example, there are societal benefits of energy conservation and the use of renewable energy technologies, such as reduced air pollution emissions. These measures can be given proper economic consideration in utility decision-making, relative to the full cost of conventional energy sources.

However, we are concerned that many utilities are more concerned with the short-term issues of meeting their projected peak-load requirements (which will maximize their system capacity factors) than with energy conservation. For instance some utilities emphasize ice storage systems for providing off-peak air conditioning, but these systems have up to a 30% reduced energy efficiency relative to conventional chilled water systems. We believe that DOE support of IRP programs can assist utilities in considering the benefits of energy conservation as well as demand-side management.

Funding Distribution

The DOE has recently directed most of its funding to supporting its laboratories, with only a very modest fraction being contracted to industry and universities.

In a cheap-oil economic cycle, the industrial sector has limited incentives to undertake privately funded energy conservation experiments. Unless the market for new products is evident in the short-term, companies tend not to risk capital for the required research and development. Many of the solar energy system successes have resulted from federally supported commercialization activities. These have involved industrial participation in research, development, and demonstration. Similar advances are anticipated by greater industrial participation in federal energy conservation activities.

Universities have experienced significant reductions in DOE funded programs in the 1980's. Universities offer two key advantages that compel their participation in more DOE-funded research in the future.

1. The next generation of building designers will receive their education at universities, not the governmental research laboratories. These students are going to face problems of energy apathy, unless changes are

made in the near future. Design practitioners tend to look to state agencies, universities and professional/technical organizations rather than to the governmental laboratories for information on new technologies. Therefore, universities should be active participants in more DOE-funded research and development programs. In addition, they should obtain increased support for the development of educational and training programs in energy conservation.

2. Direct and indirect costs for sponsored research at universities are lower than those of the government laboratories. However, university personnel are involved in both teaching (learning) and research, so a longer response-time is generally required for project development and completion. Nevertheless, the university environment and its unique resources of graduate students and faculty members, can lead to the development of innovative solutions to tomorrow's problems. Universities should be supported and involved in energy conservation research.

In the recent past due to shrinking budgets and a decreased focus on energy conservation, there has been greater emphasis on maintaining core capabilities at the national laboratories. We believe that now is an appropriate time to develop a more balanced distribution of funds among the universities, industries, and national laboratories. This would take advantage of the unique opportunities in talent, facilities, and perspectives offered by each of these national resources.

Summary

We do not support the proposed reduction in the FY 1992 Budget Request for the DOE Energy Conservation programs to 66% of their FY 1991 funding level. We believe that now is the time to increase rather than reduce efforts at developing and demonstrating improved energy conservation technologies.

The National Energy strategy projects increased energy conservation in order to meet the future national requirements. However, we doubt that the proposed funding will be adequate to develop the technology base and overcome market barriers to meet its projected reduction in national energy demand.

We support the proposed increase of funds (27%) for the conservation activities in the buildings, industry, transportation, and utility technologies sectors of the Energy Conservation Budget. However, we oppose the extremely sharp cuts in funding for technical and financial assistance, which would provide only 17.5% of FY 1991 budget.

This statement expresses the views of the Energy Conservation Task Force of the Solar Energy Division, a group of experts in the field, rather than an official position of the ASME.

APPENDIX

MEMBERS OF THE ASME ENERGY CONSERVATION TASK FORCE

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University of Virginia, Thornton Hall
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DETROIT DIESEL
CORPORATION

April 24, 1991

Dr. Eileen C. Lee, Ph.D.
Staff Director
Subcommittee on Environment
Committee on Science, Space and Technology
U.S. House of Representatives
388 HOB Annex 2
Washington, D.C. 20515

Dear Dr. Lee:

It was a sheer pleasure to meet last Thursday with you and Messrs. Curt Stanford and Jack Eisen. The Detroit Diesel Corporation management team was delighted with my report regarding your enthusiastic interest in diesel engine technology.

I encourage you and other members of your staff handling diesel and related technologies to visit DDC's world headquarters here in Detroit. We have an outstanding collection of diesel engine technology on display in our Engineering Laboratory that you will find educational and beneficial. DDC is the leading innovator in diesel engine technology and is striving to develop technology that contributes to achieving our National Energy Strategy of energy independence and efficiency as well as a clean environment.

In line with the need to have a viable NES, industry is pursuing a wide array of generic technology, alternative fuel engine and hybrid propulsion system development programs. Alternative fuels include methanol, ethanol, compressed natural gas, liquified natural gas and coal/water slurry. Ultimate success in these endeavors will be gauged by our ability to commercialize the above technology thereby preserving and creating a viable industrial base. To that end, DDC will be shortly disclosing emission certification of a transit coach, methanol fueled, heavy duty diesel engine. This event will make DDC the first manufacturer to achieve such a major milestone with a heavy duty, compression ignition engine.

In 1987, diesel engines used in the transportation sector accounted for 17.4% of the 5.7 billion barrels of petroleum consumed in the U.S. On-highway, heavy duty diesel engines accounted for approximately one half or, to be more precise, 8.8 of the above 17.4 percentage points. Technology developed for on-highway HD engines under DOE Conservation and Renewable Energy funded programs is invariably transferred to HD diesel engines used in other market sectors. Thus, this transfer of technology provides a two to one leverage in terms of getting technology into the field where it will have an impact on energy consumption

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DA 1

and the environment. The HD diesel engine industry therefore plays a key role in developing products resulting in environmentally acceptable and balanced use of our energy resources.

DDC supports the Heavy Duty Transport technology and alternative fuel development programs being managed by DOE Conservation and Renewable Energy, Transportation Technologies. However, if we are to achieve the objectives of our NES, additional funding is needed. Failure by Congress to significantly increase funding in this area beyond what was envisioned prior to the Persian Gulf Crisis will send a clear signal to both industry and society that Congress is uncommitted to our NES.

In line with the above discussion, DDC is making the following program recommendations for inclusion as line items (the **bolded language** below) under Transportation Technologies, DOE Conservation and Renewable Energy budget for fiscal year 1992:

1. Conducting Ceramic Glow plug

   With many of the alternative fuels, including natural gas, methanol and ethanol, it is difficult to obtain ignition in compression ignition engines because of the fuel properties. Therefore, ignition assistance is often needed, especially at low ambient temperatures and at lighter loads. The most common and most attractive way to provide ignition assistance in these engines is to use a glow plug. With the frequent use demanded in alternative fuel engines, commercial metal and metal-ceramic glow plugs have been unable to meet the demand for reasonable durability. A new concept of a conducting ceramic glow plug has been proposed and it has potential for much longer life because the electrically-heated filament and shell are combined into one unit. Funding is needed to develop and evaluate the conducting ceramic glow plug for alternative fuel engines. This technology could also be used to improve cold startability of commercial as well as conventional fuel compression ignition military engines, which has been and still is a concern at ambient temperatures below 35°F.

   The conducting ceramic glow plug has the potential to give greatly increased life in compression ignition engines using alternative fuels; therefore, an additional $500K is provided for research, development and evaluation of conducting ceramic glow plugs.

The use of advanced materials, including ceramics, in diesel fuel injection systems has the potential to reduce exhaust emissions, lower engine costs, and increase engine life; therefore, an additional $600K is provided for research, development and evaluation of advanced materials for diesel fuel injection plungers and control valves.

4. Heavy-duty Ozone Reduction

Alternative fuel heavy-duty engines can reduce exhaust emissions and will change the nature of the hydrocarbon emissions produced. Because the hydrocarbon species will be different, the potential to form ozone in urban atmospheres may vary considerably among engines with the same total hydrocarbon emissions. Therefore, there is a need to characterize hydrocarbon emissions from heavy-duty engines using alternative fuels and make a comparison to conventional fuel diesel engines. The results may significantly influence the choice of alternative fuel engines to reduce ozone formation in urban areas.

The potential of alternative fuel heavy-duty engines to reduce ozone formation in urban areas needs to be evaluated; therefore, an additional $400K is provided for hydrocarbon characterization of exhaust emissions from alternative fuel heavy-duty engines and comparison to diesel engines.

5. Advanced Diesel Engine Component Development

DOE has been funding the development of technology for meeting the 1994 emission standards and for the development of the "21st Century Truck Engine." This generation of on-highway truck engines must be more fuel efficient and meet more stringent emissions standards than today's engine.

Demonstration of advanced concepts has been successful but limited to a single cylinder test bed engine. Recent injection system development has resulted in successful demonstration of achieving 1994 emission standards but with degraded fuel economy. Incorporation of inherently more fuel efficient, advanced components demonstrated on the single cylinder test bed, may facilitate recoupment of the above loss in fuel economy. Specifically, demonstration of an alternate high pressure injection system, an electronically controlled in-cylinder lubrication system, an enhanced electronic valve actuation system and in-cylinder ceramic components in a state-of-the-art multi-cylinder engine capable of achieving 1994 and 1998 emission standards with minimal fuel economy trade-off is recommended.

2. Charged Injection

To achieve lower exhaust emissions from diesel engines, the fuel injection pressure is being increased considerably. The higher pressure provides increased dispersion and mixing of the fuel in the combustion chamber which improves combustion. However, use of these high pressures requires engine redesign and increases engine cost. A new fuel injection technology has the potential to dramatically lower injection pressures while improving fuel dispersion and mixing. This technology employs solid state electronics to apply an electrostatic charge to the fuel to increase atomization and dispersion. The amount of charge can be adjusted for variables such as the engine operating condition or fuel quality. Although this general technology has been used for various purposes, including paint spraying, its application to engines requires considerable research and development.

> **The use of charged fuel injection in engines has the potential to significantly reduce fuel consumption, reduce exhaust emissions, lower engine costs and allow use of less expensive fuels; therefore, an additional $1 million is provided to accelerate research, development and evaluation of the charged fuel injection concept currently under development by U.S. industry.**

3. Ceramic Fuel Injector Parts

Fuel lubricates and cools parts throughout an engine's fuel system. Conventional diesel fuel is non-corrosive and has good lubricity and diesel fuel systems have evolved from these properties. Alternative fuels, and to a lesser extent reformulated diesel fuels, provide a more hostile environment for fuel system components. To provide acceptable reliability and durability with these fuels, advanced materials, such as ceramics, will be required for some parts. The need for improved materials is intensified by the increased demands on fuel injection systems to reduce exhaust emissions and maintain these lower emissions throughout an engine's life. The most important applications for advanced materials are the injector plunger, which creates the injection pressure, and the control valve, which determines the injection timing and quantity. Both of these parts are made to very high precision, so design and manufacture using advanced materials represents a sizable challenge. Successful application of these materials will create additional markets and expand use of new materials.

The kinematic Stirling engine uses continuous combustion of any fuel external to the engine resulting in ultra-low emissions compared to the intermittent combustion of a specific fuel in gasoline or diesel engines. In addition, the newly developed variable displacement Stirling engine combines low noise and vibration and high fuel efficiency over the entire power range of the engine while eliminating the leakage and reliability problems which plagued earlier designs.

[The Stirling cycle is a generic name for a machine with an external heat source and an enclosed working gas. This Stirling engine is not the MTI Stirling engine nor is it used as the primary propulsion engine in an automotive application.]

Funding is needed to integrate the variable displacement, kinematic Stirling engine into a hybrid electric propulsion system and to demonstrate the quiet, multi-fuel, high efficiency, ultra-low emissions and reliability of this system in urban bus applications.

> **"The variable displacement kinematic Stirling hybrid electric propulsion system, with multi-fuel capability, ultra-low emissions, high fuel efficiency and low noise, is capable of meeting the most stringent emissions requirements foreseeable for urban buses in the mid- and long-term future; therefore, an additional $1.5 million is provided for integration, demonstration and evaluation of this advanced system."**

Please feel free to call me at (313) 592-5441 if there is a need for further clarification or revision of any of the language in this letter.

Sincerely,

Peter L Perdue

P. L. Perdue, Manager
Business Development

PLP:jm-02(g)

Incorporation of advanced diesel engine components into a multi-cylinder engine has the potential to facilitate achievement of the 1994 emissions standard with enhanced fuel economy and provide critical building block technology for development of the 21st Century Truck Engine. Therefore, an additional $1 million is needed for integration and demonstration of this technology in a state-of-the-art multi-cylinder engine.

6. Hybrid Propulsion System

Development and production of all-electric vehicles to meet the stringent emissions standards in California, New York, Massachusetts and other states is hampered by the limited range of systems using current or emerging battery–technologies. A promising alternative is the hybrid electric propulsion system which uses an on-board means of charging the batteries from another energy source, resulting in extended vehicle driving range and longer battery life. For an urban driving cycle, the output power required of the on-board battery charger is only a fraction of that of the primary propulsor.

Options for the power source for charging the batteries include small diesel, gasoline and Stirling engine driven generators as well as fuel cells; however, the consensus opinion among leaders in the transportation industry is that fuel cell-electric and Stirling-electric hybrid propulsion systems are the only viable alternatives for replacing the on-highway, heavy duty diesel engine in automotive applications.

Fuel cell technology is not mature enough to manufacture fuel cells of a size practical for battery charging in a hybrid propulsion system. Their size and weight alone, exclusive of the primary batteries, dwarfs that of current primary propulsion internal combustion engines.

On-board combustion engines for driving the generator battery chargers have several common attributes with current primary internal combustion engines. The lower output power requirement however will permit scaling down their physical size and weight accordingly. The Stirling engine is the most promising prime mover for the generator. Recent technological developments have shown it possesses the greatest potential in terms of meeting future urban bus emission requirements without sacrificing durability, reliability, performance and fuel economy of current diesel bus engines. Furthermore, its technology is more mature than that of fuel cells and will require less development time and resources for commercialization as well as provide more fuel flexibility and efficiency.

GAO
United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

May 16, 1991

The Honorable James H. Scheuer
Chairman, Subcommittee on Environment
Committee on Science, Space,
  and Technology
House of Representatives

Dear Mr. Chairman:

During your April 17, 1991, hearing on the Department of Energy's (DOE) energy conservation budget request, we discussed energy pricing and the costs of energy use that are not reflected in current energy prices--so-called "externalities," or external costs of energy use. Damages to public health and the environment resulting from air pollution are often cited as external costs of burning fossil fuels that are not fully reflected in energy prices. Importing energy resources also involves costs, such as those associated with maintaining the nation's energy security, which have been referred to as externalities of energy use.

As you requested, this letter generally describes measures the Congress could enact to make energy prices better reflect the external costs to society of energy use. First, we discuss measures that directly influence the price of a commodity upward to better reflect the external costs to society of using the commodity. These measures invariably involve taxes of some kind. Also, we briefly address other approaches the Congress may consider to limit the formation of externalities, including measures such as tax credits, subsidies, and mandates. As discussed with your staff, we plan to prepare a qualitative analysis of the relative merits of some of these proposals later this year.

MEASURES TO INCORPORATE EXTERNAL COSTS INTO THE PRICE OF ENERGY

The following are measures that DOE, the Congress, and others have considered, or are considering, to raise energy prices to better reflect external costs. Some of these measures directly focus on oil consumption while others broaden the tax base to include other fossil fuels such as coal and natural gas and nonfossil fuels such as nuclear, hydroelectric, and geothermal. DOE considered several of these measures for inclusion in the National Energy Strategy (NES) (however, none were ultimately included), and we discuss DOE's considerations where appropriate.

Broadly Based Energy Taxes

-- Ad Valorem Tax: This measure would tax all sources of energy at a rate equal to some percentage of the selling price. Typically, such a tax would be imposed on consumers at the point of final sale, but could be imposed at the producer stage (minehead or wellhead) or at some later point in the production, distribution, or marketing chain. The administration, in developing the NES, considered and rejected a 15-percent ad valorem tax to be applied at the point of final sale.

-- Btu Tax: This measure would impose a tax on all fuels according to the heat content of the energy source as measured in British thermal units (Btu).[1] Such a tax could be applied at the production, wholesale, or consumption stage. The administration considered and rejected for inclusion in the NES a tax on all fuels at a rate of $1 per million Btus.

-- Carbon Tax: This measure would tax fossil fuels on the basis of their carbon content. Such a tax could be imposed where fossil fuels initially enter the economy (such as taxing coal at the minehead) or at the point of carbon emission. Also, the carbon tax could be used to provide subsidies for "biomass offsets," such as planting trees. The administration considered and rejected, as part of its NES deliberations, a carbon tax of between $35 and $135 per ton of carbon emitted.

Measures Directed at the Consumption of Oil

-- Gasoline Guzzler Tax/Sipper Rebate: This measure would impose a graduated tax on the basis of fuel economy ratings below a given threshold level and a graduated rebate for fuel economy ratings above the threshold level. This measure could be structured to collect taxes from manufacturers of fuel-inefficient autos and provide rebates to purchasers of fuel-efficient autos. A gas guzzler tax currently exists for passenger autos with fuel economy ratings below 22.5 mpg. DOE, in developing the NES, considered and rejected raising this threshold level and adding a consumer rebate provision.

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[1] A Btu is the quantity of heat required to increase the temperature of 1 pound of water 1 degree Fahrenheit.

-- Sliding Registration Fee: This measure would combine consumer incentives for fuel efficiency and emissions reduction by collecting additional registration fees on fuel-inefficient, high-polluting autos and rebating these fees to fuel-efficient, less-polluting autos through existing state automobile registration mechanisms.

-- Gasoline and Diesel Fuel Excise Tax: This measure would incrementally increase the fuel tax to a specified price; the tax would escalate at a rate faster than the underlying rate of inflation to ensure that the relative price of fuel increases. The administration, in developing the NES, considered and rejected imposing a 10-cents-per-gallon tax on highway gasoline and diesel fuel beginning in 1993, increasing by 10 cents per gallon each year to a maximum of 50 cents per gallon in 1997. Under this proposal, some of the tax revenues would have been refunded to consumers through offsetting reductions in other taxes, with a portion earmarked to finance the research and development of alternative fuels and alternative fuel vehicles.

-- Repeal Exemptions From Current Gasoline Taxes: This measure would repeal exemptions from existing federal gasoline taxes. Farm and other off-highway users of gasoline are exempt from federal gasoline taxes, as are state and local governments and school districts.

-- Excise Tax on Imported and Domestically Produced Oil: This measure would tax each barrel of crude oil, domestic or imported, entering the U.S. economy. A version of this tax could be a "refinery gate" tax--a tax imposed on oil purchased by a refinery or brought into one.

The above list is by no means exhaustive. As mentioned during the hearing, some groups are proposing innovative tax proposals related to energy use. For example, one proposal suggests incorporating the cost of vehicle insurance into the price of gasoline, thus linking the cost of insurance coverage to the number of miles driven. With cooperation from gasoline retailers and insurance providers, consumers would purchase vehicle insurance as an additional fee when buying gasoline rather than purchasing insurance directly from an insurance provider. Further, some taxes could be imposed at the state level, including a variable state vehicle sales tax determined by the efficiency of the vehicle compared with others in its size class.

OTHER POLICY APPROACHES TO LIMIT EXTERNAL COSTS

In addition to measures that directly influence the price of a commodity, several other policy approaches are available to address the external costs of using energy. Tax credits, subsidies, and/or mandates can reduce the extent of external costs. First, certain tax credits, such as investment, production, and/or income tax credits related to renewable energy resources, can encourage energy producers and users to use less environmentally damaging energy resources and technologies. Additionally, tax-free rebates can encourage consumer purchases of energy-efficient and more environmentally sound appliances. Finally, regulatory standards or mandates can result in lower external costs. For example, higher Corporate Average Fuel Economy standards for vehicles could limit environmental damage to the extent that less fuel is consumed.

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Although the external costs of energy use are integral to the energy policy debate, scientific uncertainties remain about the size of the externalities. It is, therefore, difficult to determine the size of the taxes necessary to incorporate externalities into energy prices, the size of the tax credits and subsidies to influence energy resource and/or technology choices, and the nature of the standards designed to reduce energy use. Additionally, tax measures have other economic costs associated with them, the severity of which depends on a variety of factors, including what the size of the tax will be, whether it is phased in over time, and what the economic conditions are at the time the tax is imposed. Fiscal or monetary policies, such as offsetting tax increases with other tax reductions or lowering interest rates by expanding the money supply, might need to be enacted to compensate for some of these economic costs.

Given these considerations and the fact that we have not done extensive analysis in this area, we do not necessarily endorse any of the measures discussed above nor recommend their adoption and/or implementation. As mentioned previously, however, we do plan to continue evaluating some of these issues. If you have any further questions about this information, please contact me at (202) 275-1441.

Sincerely yours,

Judy England-Joseph

Judy A. England-Joseph
Associate Director, Energy Issues

MARKUP OF DOE AUTHORIZATION FOR FISCAL YEARS 1992 AND 1993

THURSDAY, MAY 2, 1991

House of Representatives,
Subcommittee on Environment,
Committee on Science, Space, and Technology,
Washington, DC.

The subcommittee met, pursuant to call, at 2:17 p.m., in room 2318, Rayburn House Office Building, Hon. James H. Scheuer (chairman of the subcommittee) presiding.

Mr. Scheuer. The Subcommittee on Environment will come to order. Today we will do the markup for the Department of Energy for fiscal years 1992 and 1993.

Today, the Subcommittee on the Environment is considering an authorization for fiscal years 1992 and 1993 of five programs within the Department of Energy. Specifically, they are solar and renewable energy R&D; energy conservation R&D; environment, safety, and health R&D; biological and environmental research; and the liquefied gaseous fuels spill test facility.

This is the first year that this subcommittee has had the responsibility for DOE's budget in the area of energy conservation and solar and renewable energy. While this new jurisdiction would be viewed as a significant challenge in any Congress, this year, because of the introduction of the National Energy Strategy, we have seen a heightened interest in these programs. And it is particularly of interest to me and, I judge, to the members of the subcommittee.

It is perfectly clear that our Nation must develop a strategic policy with respect to energy production. The energy crises that commenced in 1973 with the Arab oil boycott focused the Government's attention on the need for energy independence. As a result, Federal Government investment in energy supply R&D peaked and considerable gains were made in the area of renewable energy sources and energy conservation.

In the early 1980s, the Federal Government commitment to energy foundered on the rocks of a misguided doctrine that market forces would determine our national energy policy. In the interim, we have become much more aware of the contribution that fossil fuels are making to global warming, greenhouse gases, acid rain, and other threatening weather phenomena. The problems surrounding the use of nuclear energy have not abated, and a war has been fought to preserve our access to Persian Gulf oil.

It is long overdue for this Nation to establish its priorities with respect to energy supply and energy consumption. In a time of limited financial resources where we cannot do everything, but where we know we can do almost anything, it is clear that we must make investments in technologies which are capable of supplying our near-term energy needs in an environmentally sustainable fashion.

There is little doubt that our national dependence on imported oil is unsustainable, and therefore unacceptable. Hopefully, we will be successful in encouraging Mexico to supply with a continuous reliable supply of oil. While this may minimize our dependence on OPEC, we will surely have failed to confront the equally compelling issues of global warming, acid rain, and urban smog that are produced by excessive consumption of fossil fuels.

The price we pay for basing our energy economy on fossil fuels is well beyond what either we or the world can afford. While fossil fuels will continue to be an integral part of our energy supply portfolio, we should begin to emphasize bridge fuels, such as compressed natural gas in the transportation area.

Renewable energy sources are abundant and can ultimately displace much of our requirement for oil. But that may be 20 or 25 years down the road, and in the meantime compressed natural gas could be the bridge fuel that would continue leaning out our dependence on fossil fuels for the next decade or two until the time that we have an abundant supply of renewable energy resources.

Our Nation has made impressive strides in energy efficiency in the 15 years following the oil crisis commending in 1973. However, in the last few years energy demand has increased in all sectors of the economy. In order to stay even with respect to demand, we must invest in the next generation of energy efficient technologies. No matter how we produce our electricity, be it from clean coal plants, nuclear plants, wind turbines, or hydroelectric plants, investments in energy conservation R&D and improved energy efficiency technologies are inherently sensible and are now a categorical imperative.

Utilities industry executives have long since learned that the cheapest source of additional power is the power you already have, if you can squeeze it, shrink it, massage it and make it go farther through a whole variety of energy conservation technologies.

I now yield to the distinguished ranking Republican member of the subcommittee, Congressman Don Ritter of Pennsylvania.

Mr. RITTER. Thank you, Mr. Chairman. And, I want to commend you for your leadership in bringing before us today this markup vehicle, which I believe is a helpful step forward towards development of the National Energy Strategy. The mark-up vehicle, as you have mentioned, proposes overall funding at the level requested by the President for the Biological and Environmental Research (BER) Program; Environment, Safety, and Health Program (ESH); and the Liquefied Gaseous Fuels Spill Test Facility.

The mark-up vehicle also proposes increases in funding for programs which are at the core of a responsible national energy strategy. It contains research and development to reduce the uncertainties associated with renewable energy and move forward toward greater use of these resources. It contains research and development in energy conservation and in greater energy efficiency, with the potential to reduce energy costs to consumers and enhance the quality of our environment.

Conservation efforts are essentially beneficial, since they promote a strong economy and help break us away from a dangerous addiction to imported oil. The near doubling of our commitment to hydrogen research and development is also in our budget.

One promising conservation effort, Mr. Chairman, in this budget is the Metals Initiative, encompassing R&D efforts to save energy in the steel and aluminum industries. I am pleased that the mark-up vehicle includes continued funding at the level requested by the President, $18 million, for this important program.

Mr. SCHEUER. Will the gentleman yield briefly?

Mr. RITTER. Yes, I certainly will yield.

Mr. SCHEUER. I wish to commend the gentleman from Pennsylvania especially for his outstanding leadership in pushing this concept and involving this subcommittee in this very constructive effort. The gentleman has exhibited really remarkable leadership and I congratulate him for that.

Mr. RITTER. Gee! Thank you, Mr. Chairman. What a delightful comment. And, let me just commend the Chairman on his comments about working more closely with Mexico and bringing in—being, perhaps, less dependent on Persian Gulf oil and more dependent on Mexican oil. Their being a neighbor and the Persian Gulf's being highly unstable, it seems to me like an excellent rationale for fast track and a North American free trade agreement.

Mr. Chairman, I must say, after all of that, I am a little disappointed that the mark-up vehicle does propose sharp increases in funding for the renewables and conservation program, perhaps too sharp. The solar and renewables budget would jump by 48 percent under the proposal before us, and the energy conservation budget would increase by 33 percent. In this time of tight budgets, perhaps these increases go a little too far, particularly in the solar and renewables program. Although I do support substantial increases, perhaps we have just pushed a little too far.

Mr. Chairman, I do support your goal of developing a national energy strategy which loosens the grip of imported oil on America, while yielding economic and environmental benefits. These programs are an important component of such a policy. They endured budget cuts in the Eighties. And many in Congress, including the Budget Committee, recommend sharp increases in FY 1992 for R&D, and renewables and conservation. Yet, the Subcommittee goes even beyond the sharp increases of the Budget Committee.

I feel the Subcommittee has an obligation to be realistic about what it can and can't accomplish in the next two fiscal years. It seems to me that when we put increases of this magnitude into our budgets, we don't end up being credible to the Appropriations Committee. And sometimes, we may hamper the ability of the committee as a whole to stay within or near the Budget Committee's deliberations, certainly the President's budget. And, we tend to allow the Appropriations Committee to set the priorities for us, rather than vice versa.

With that, Mr. Chairman, I yield back the balance of my time.

Mr. SCHEUER. I thank my colleague.

Congressman Howard Wolpe from Michigan.

Mr. WOLPE. I thank you very much, Mr. Chairman.

Mr. Chairman, I want to commend you for the mark that you are presenting to the subcommittee for consideration. There are some very significant increases in funding proposed here on the conservation and renewable side of the energy budget, but I think it is useful to put in perspective the fact that even with these increases in this budget we still will be far short of the commitment that would have been in place right now had we simply stayed on track with the 1981 program that was then in place.

The fact of the matter is we have been harmed very dramatically by our failure to sustain the kinds of funding and emphasis in these areas that had been originally anticipated a decade ago, so we have got a lot of catch up to do.

Let me also say, however, that I share Mr. Ritter's observations about the importance of staying within the President's numbers. I think we all understand that when this bill, our bill comes out of the full committee we will have to be within the President's numbers. And so it is my intention to offer an amendment in full committee that would provide the room for these increases in the overall product of that full committee. Because I think there are some increases in the Energy Subcommittee's work that I have great difficulty supporting, and I think make no sense from the standpoint of a rational national energy strategy. So we will have that debate in full committee, and it is certainly my expectation that when we finally emerge with a final product it will, in fact, be within the President's numbers.

Thank you.

Mr. **Scheuer**. Congressman Morrison of the State of Connecticut.

Mr. **Morrison**. How about Washington?

Mr. **Scheuer**. Oh. State of Washington. I am sorry.

Mr. **Morrison**. That one is no longer with us, Mr. Chairman. We miss him.

I love these numbers. I wish I had the confidence that we could sustain them, Mr. Chairman. So, instead of joining in the chorus of commendations, even though I would love to, I am eager to get into the session itself. So, we can see what in fact is your intent to advance in theory, as well as in the actual numbers that we are able to utilize. Since I do understand there was some sort of a meeting that we weren't party to, with Chairman Brown, with some numbers assigned to the Subcommittees, I just want to know how we are going to work in relationship to those.

And, I am eager to support you. I love all the programs that you have expanded.

Mr. **Scheuer**. Before I recognize Congresswoman Horn, I will state that no numbers whatsoever were assigned to the subcommittee. Absolutely not true. Congresswoman Horn.

Ms. **Horn**. Thank you, Mr. Chairman. I do have a statement that I will submit, but I also concur with the previous speakers, and I am pleased to hear Mr. Wolpe's indication that the numbers will be addressed and will look forward to that happening. I also believe we need to do more with renewable alternatives and conservation, and that will certainly be the direction that I will be looking, and I will be anxious to hear how the numbers will be reconciled.

Thank you.

[The opening statement of Ms. Horn follows:]

Opening Statement of Ms. Horn

for the Markup of the

DOE R & D Programs Reauthorization

Mr. Chairman and distinguished colleagues, today we have an opportunity to influence the energy policy of our nation. A few months ago, the President released his National Energy Strategy for the coming decades. Unfortunately, many of us in Congress were disappointed by the lack of leadership apparent in this NES.

Of particular concern is the emphasis in the NES on increased domestic oil drilling and nuclear power, with the notable absence of focus on alternative energy sources, including renewable energy, alternative fuels, and conservation.

Given that any energy obtained from the nuclear power and increased drilling initiatives in the NES will take a decade or more to become available, it seems prudent to invest some of the money earmarked for these programs in renewable energy sources. Energy from renewable sources would be available within a similar, or shorter, timeframe. In addition, as it is renewable it would continue to be available for decades or even centuries to come, rather than be depleted within a few decades, as will any oil reserves in ANWR or coastal regions. It will also be easier to bring renewable energy plants on-line than nuclear power plants. There have been no new orders for nuclear plants since 1978. It is therefore unrealistic to plan on increased electrical demand being met by nuclear power, much less a doubling of nuclear capacity. Wouldn't it make more sense to put some of the relatively large amounts of money to be spent on nuclear power into less difficult to site renewable energy plants. The Subcommittee is not requesting that all of the funds earmarked for nuclear programs be redirected to renewable energy, only a portion of them.

Another area of concern is alternative fuels. We now have the capacity to use domestically produced alternative fuels, such as ethanol, as a component of gasoline. Use of these fuels is not only good energy policy, but good trade and farm policy as well. It reduces our reliance on foreign oil and gives our farmers a new use for surplus corn. Additional R & D funds for alternative fuels are likely to increase the availability, variety and potential uses of these fuels. Surely this represents a potential payoff and a more prudent use of scarce funds than more money for the nuclear power industry or the oil companies. As transportation represents the largest use of oil in our economy, any developments in this area will be particularly significant.

Conservation is another area of importance. Even modest energy conservation programs, such as increased efficiency in buildings would save as much, or more, energy as could be obtained from the extraction of oil from environmentally sensitive domestic regions such as the ANWR. Moreover, these savings continue year after year, as long as the increased efficiency methods are continued, unlike oil reserves which run out.

In conclusion, if the choice is between more money for oil drilling and nuclear power on the one hand, and other energy programs on the other, I think it is good policy to increase the investment in renewable energy sources, alternative fuels, and energy conservation and efficiency. These programs represent the best chance for long-term payoffs in the future. I thank the Chairman and the Committee for the opportunity to state my views on this matter of vital national interest.

Mr. **Scheuer**. Connie? Congresswoman Morella?

Ms. **Morella**. I simply want to echo everything that has been said. It is a very important authorization for Department of Energy, and I certainly feel that it is appropriate that we put more emphasis on energy conservation.

So, on with the work of this wonderful subcommittee whose members I commend.

Mr. **Scheuer**. Thank you.

[The prepared opening statement of Mr. Swett follows:]

OPENING STATEMENT OF THE HONORABLE DICK SWETT
ENVIRONMENT SUBCOMMITTEE MARK-UP
May 2, 1991, Rayburn House Office Building

Thank you Mr. Chairman. I am pleased to see that you have moved this important authorization so quickly to mark-up. I believe that we must invest in research into renewable fuels and energy conservation if we are to wean our nation of its dependence on foreign oil.

I know that we have a busy agenda today, but I just hoped to bring up one issue that I believe is of extreme importance, and I hope some language incorporating my concern will be included in the subcommittee report.

The Federal Government is currently one of the biggest energy users in the world. And as has been noted time and again in our hearings, little is being done by the Federal Government to conserve. The halls of Congress are still lighted by inefficient incandescent bulbs. Changing the bulbs in these buildings to fluorescent bulbs would cut the energy needed to light the halls of Congress by 30%. All that just by changing lightbulbs.

Witnesses have stated again and again that although more research into conservation is still needed, many technologies already exist that are inexpensive and would save enormous amounts of energy. Legislation has made it possible for agencies to install some of these technologies at no cost to their own budgets. But the Federal Government has not taken advantage of these opportunities.

Mr. Chairman, the President deserves credit for his executive order urging better conservation. I hope some successes will come of it. But we in Congress must continue to be vocal advocates urging the Federal Government to lead the way in energy conservation. It is in our nation's best interest.

Mr. Chairman, thank you for this time and I yield back what remains of it.

Mr. SCHEUER. All right.

I ask unanimous consent that it be made in order for the Subcommittee to consider a committee print, to consider the print as an original text for mark-up purposes, and to consider the print as being read and open for discussion.

Hearing no objection, the Chair now calls up the committee print for consideration.

SOLAR AND RENEWABLE ENERGY

	FY 91 Estimate	FY 92 Request	FY 92 Recomm.	Rec. vs. Request	% Over Request
		(THOUSANDS)			
SOLAR	124,754	139,666	225,454	85,788	61
GEOTHERMAL	27,252	20,170	23,000	2,830	14
ELECTRIC ENERGY SYSTEMS	27,998	30,757	32,757	2,000	7
ENERGY STORAGE SYSTEM	12,746	7,246	10,246	3,000	41
TOTAL	192,750	197,839	291,457	93,618	47

Descriptions of Changes

The Subcommittee authorizes the Department FY 1992 budget request of $197,839,000 with an increase of $93,618,000 and further recommends an authorization level of $335,176,000 for FY 1993.

In the Solar Program, the Subcommittee authorizes an increase of $3,026,000 for Solar Building Technology including solar heating research and solar buildings energy systems research; $14,200,000 for Biofuels Energy System including crop development and demonstration, thermochemical conversion, biochemical conversion, and direct combustion; $11,056,000 for Wind Energy Systems in the areas of structural and fluid dynamics, development of an advanced wind turbine, storage technologies, development of advanced hybrid systems, component research and cooperative research with the private sector; $29,506,000 for Solar Thermal including research to develop solar detoxification technologies, collection technology research, energy conversion technologies, distributed receiver technology; $28,000,000 for Photovoltaic research including collector research, systems research aimed at integrating this technology into utility sector, development of advanced thin-film materials in cooperation with the private sector and development of cost effective high efficiency materials; and increased program direction.

The Subcommittee authorizes $23,000,000 for the Geothermal Program which reflects a $2,830,000 increase in funding for hydrothermal resources R&D including technology transfer activities.

The Subcommittee authorizes $32,757,000 for the Electric Energy Systems Program which includes an increase of $2,000,000 for DOE participation in the development of a national research program in cooperation with the Environmental Protection Agency and the private sector on the possible health effects of exposure to electromagnetic fields (60 hertz). The costs of such a national research program are to be shared equally by the private sector and the federal government.

An increase of $3,000,000 for hydrogen research including production, storage system development and end-use technologies is contained in the Energy Storage Systems Program which is authorized at $10,246,000. The costs of such a research program will be shared equally by the private sector and federal government.

ENERGY CONSERVATION

	FY 91 Estimate	FY 92 Request	FY 92 Recomm.	Rec. vs. Request	% Over FY 92
		(THOUSANDS)			
Building Tech.	35,088	38,937	70,000	31,063	80
Industrial Tech.	80,269	97,110	120,000	22,890	24
Transportation Tech.	81,759	104,668	134,000	29,332	28
Utility Tech.	4,249	6,800	11,000	4,200	62
TOTAL	201,365	247,515	335,000	87,485	35

Description of Changes

The Subcommittee authorizes the Department FY 1992 budget of $340,000,000 for Energy Conservation which includes an increase of $88,885,000 and recommends an FY 1993 authorization of $392,150,000.

The Subcommittee authorizes $70,000,000 for the Building Technologies Program in FY 1992 which contains an increase of $31,063,000 for additions to the core program in solar technologies research including daylighting analysis and electrochromic window technology; development and implementation of a cost sharing project with private industry and states on high performance envelope integration of solar energy into energy efficient buildings; materials and development; lighting and appliances; heating and cooling equipment including joint ventures for testing new heat pumps in cooperation with the Gas Research Institute; indoor air quality research; building system research; and increased program direction.

The Subcommittee authorizes $120,000,000 for the Industrial Technologies Program for FY 1992 with an increase of $22,890,000 for core programs in the following areas: demonstration project with gas industry to evaluate the technical and economic feasibility of using oxygen rich waste streams from nitrogen supply systems in industrial cogeneration systems; development and testing of ceramic prototypes for blades, rotors, combustor and recuperator; expanded separation technology research; development of continuous fiber ceramic composites to improve energy efficiency; expanded program in engine combustion processes and materials development; improved electrical drives, expanded industrial waste research; design of planar solid oxide fuel cell and application demonstration to be done on a cost shared basis with the Gas Research Institute and private industry; and increased program direction. This authorization also includes $18,000,000 for continuation of activities under the Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988.

The Subcommittee authorizes $134,000,000 for the Transportation Program which contains an increase of $29,332,000 for the core programs in the following areas: a project to reduce the cost of producing ceramic automotive components and improve machinings and finishings; tribology R&D to solve materials related problems and accelerate the introduction of alternative low emissions fuels; engine optimization program using alternative fuels; comparative study of light vehicle source energy and fuel utilization efficiency; electric and hybrid propulsion systems development and testing; development and demonstration of advanced ceramic technology for use in automotive gas turbines; design and development of engines for heavy duty trucking applications; zero-emission hydrogen vehicle joint venture and study; and increased program direction.

The Subcommittee authorizes $11,300,000 for the Utility Technologies program which contains an increase of $4,200,000 for integrated resource planning activities.

ENVIRONMENT, SAFETY, AND HEALTH PROGRAM

	FY 1991 Estimate	FY 1992 Request	FY 1992 Recomm.	FY 1993 Recomm.
		(THOUSANDS)		
SPECIAL PROJECTS	10,500	10,920	10,920	
ENVIRONMENT	17,500	18,240	18,240	
SAFETY AND QUALITY ASSURANCE	26,915	24,620	24,620	
HEALTH	51,331[a]	62,239	62,239	
PLANNING	4,100	4,100	4,100	
PROGRAM DIRECTION	20,268	20,590	20,590	
CAPITAL EQUIPMENT	1,533	1,600	1,600	
TOTAL	96,322	142,309	142,309	156,540

[a] This amount is the FY 1991 request adjusted to reflect reprogramming during FY 1991 of epidemiologic research from other program areas to the ES&H program. The actual FY 1991 appropriated level before reprogramming was $15,506,000.

The Subcommittee authorizes the Administration request of $142,309,000 for the Environment, Safety, and Health program for FY 1992, and $156,540,000 for FY 1993.

LIQUEFIED GASEOUS FUELS SPILL TEST FACILITY

	FY 1991 Estimate	FY 1992 Request	FY 1992 Recomm.	FY 1993 Recomm.
	(THOUSANDS)			
OPERATION	1,079	1,115	1,115	
RESEARCH	—	—	1,000	
TOTAL	1,079	1,115	2,115	3,000

The Subcommittee authorizes the Administration FY 1992 budget request of $1,115,000 for this program, with an increase of $1,000,000 for research activities pursuant to Sec. 901 (f) of P.L. 101-549, the Clean Air Act. The Subcommittee recommends an authorization of $3,000,000 for FY 1993, of which at least $1,775,000 is to be spent on research activities.

BIOLOGICAL AND ENVIRONMENTAL RESEARCH PROGRAM

	FY 1991 Estimate	FY 1992 Request	FY 1992 Recomm.	FY 1993 Recomm.
		(THOUSANDS)		
ANALYTICAL TECHNOLOGY	13,661	13,290		
ENVIRONMENTAL RESEARCH	36,884	36,888		
HEALTH EFFECTS RESEARCH	64,964	36,598[a]		
GENERAL LIFE SCIENCES	76,916	90,909		
MEDICAL APPLICATIONS	115,361	33,943[b]		
CARBON DIOXIDE RESEARCH	65,528	74,500		
PROGRAM DIRECTION	5,540	6,100		
FACILITIES OPERATIONS	15,018	20,332		
TOTAL	393,872	312,560[c]	311,560[d]	330,500

[a] The apparent decrease from the FY 1991 appropriated level is due to a reprogramming of $25,243,000 for epidemiologic research out of the BER program to the ES&H program.

[b] The apparent decrease from the FY 1991 level is due to a DOE decision not to fund $72,160,000 of congressionally directed projects, mandated in the FY 1991 appropriations legislation.

[c] Adjusting the FY 1991 level to account for the reprogrammed epidemiologic research and the congressionally directed projects results in a 5.4 % increase for FY 1992 in comparison with the FY 1991 level.

[d] This amount reflects an allocation of $1 million to the Liquefied Gaseous Fuels Spill Test Facility.

The Subcommittee authorizes $311,560,000 for this program for FY 1992, and $330,500,000 for FY 1993.

Mr. SCHEUER. The committee print before us authorizes appropriations in FY 1992 and 1993 for the Department of Energy's Solar and Renewable Energy Program, for the DOE's Energy Conservation Program, for the Biological and Environmental Research Program, for the Energy, Safety, and Health Program, and the Liquefied Gaseous Fuels Spill Test Facility.

In the area of solar and renewable energy, the budget proposal before you authorizes a fiscal year 1992 level of $291,457,000, in 1992, and $335,176,000 in fiscal year 1993. The administration request for fiscal year 1992 contained less than a 2 percent increase for this program despite the potential these technologies have to reduce our crippling dependence on imported petroleum.

Over the past decade the budget for renewable energy has been cut over 90 percent in real terms. Testimony received by the subcommittee overwhelmingly supported expanded R&D activities aimed at getting these technologies on the grid and otherwise in use. I believe that the funding increases proposed in this budget will help us realize the immediate potential of some of these technologies, especially photovoltaics, and bring others along on a steady path that ends with commercial development.

In the area of energy conservation R&D, the committee proposes a fiscal year 1992 authorization of $340 million, which is 35 percent above the President's request. Presently the funding level for this program is half of what it was in 1982, a decade ago, also in real terms. Energy consumption is escalating, and for reasons including the revised standards for emissions under the Clean Air Act the utility industry has strongly endorsed energy efficient technologies as the best way to meet demand.

The United States consumes twice as much energy per unit of gross national product or per unit of industrial production as do the Japanese. Improvements in energy efficiency in the industrial sector are essential if we are going to stay competitive in the global marketplace.

The subcommittee received testimony in two days of hearings on the Energy Conservation Program which overwhelmingly supported an expansion of the program's activities. The budget proposal before you contains a recommended authorization of $391 million in fiscal 1993, a level which is still less than the level of support this program received in fiscal year 1980 in real terms. So we are only playing catch up to the level of authorizations we had over a decade ago when we hadn't been through the experience of fighting a war over access to fossil fuels. The funding commitment of $391 million for fiscal 1993 will enable our Nation to make significant progress in achieving energy efficiency in major sectors of the economy.

The increases I have proposed for these programs are substantial and they are necessary. While the energy supply R&D programs were cut across the board during the Eighties, the programs in renewable energy sources and in energy conservation weren't just cut, they were decimated. It is in the national interest to rebuild these programs, and this budget makes a strong commitment to that philosophy.

I believe that the funding increases proposed for these programs are both fiscally responsible and in the long-term interest of our national security.

Why don't I just revise and extend the rest?

Are there any amendments to the proposal before us?

[No response.]

Mr. **Scheuer**. If there are no amendments, it is in order for someone to move that the bill be reported to the full committee.

Mr. **Wolpe**. Mr. Chairman, I move that the subcommittee report the committee print and to instruct the staff to prepare the subcommittee report, to make technical and conforming amendments, and that the chairman take all necessary steps to bring the bill before the full committee for further consideration.

Mr. **Scheuer**. All right. Then the question is on the motion to report the bill.

Mr. **Morrison**. Mr. Chairman, could we—I am not asking for debate, but sort of want to address it just for a moment.

Mr. **Scheuer**. Sure.

Mr. **Morrison**. On the issue of what happens to us, I think the other Subcommittees seem to be holding to a lower line. This reflects an interesting list, which I support. I will vote for Mr. Wolpe's motion. But, I guess I would like to have a little bit of discussion from whoever knows whether we can add in this amount of money and have any chance of really sending any list of priorities to the Full Committee or to the appropriators.

Mr. **Wolpe**. Mr. Chairman? I wonder if the chairman might yield to that?

Mr. **Scheuer**. Mr. Wolpe.

Mr. **Wolpe**. I think we are really pikers here. The Energy Subcommittee added on some $268 million, I believe it was, to the numbers that they originally were going with. I mean, one of the realities that we are here facing is that we are about to enter the process in which the real trade-offs will have to be made, and for our committee not to come in with what we believe as a matter of policy to be justifiable would put us at an enormous disadvantage in that debate within the full committee process.

Mr. **Morrison**. Mr. Chairman, I guess maybe I have been misled by some background information that indicates that there—somewhere with Mr. Brown, Chairman Brown, and perhaps others—there was some sort of an allocation worked out.

Mr. **Wolpe**. No.

Mr. **Morrison**. And, if that is not true, then I stand corrected.

Mr. **Wolpe**. Regrettably, it is not true.

Mr. **Morrison**. Okay.

Mr. **Scheuer**. Some of those allocations may be revisited in the full committee.

Mr. **Morrison**. Okay. That is fine.

The only other question I had, Mr. Chairman, doesn't relate to this amendment as much as the question of the form in which you are doing this is related virtually to a table. And, I was wondering if you have any suggestions as to report language. There is some detail within these expenditures that I think I would like to have a chance to express a couple of views on. I mean, how would that be handled?

Mr. **Scheuer**. I am sure that that will be easily possible. And I would suggest you have your minority staff work with Dr. Eileen Lee, and we would be happy to accommodate you on report language, any reasonable suggestions for report language.

Mr. **Ritter**. Would the gentleman yield?

Mr. **Morrison**. I'll be glad to yield.

Mr. **Ritter**. Just briefly. Since it is not known whether Mr. Wolpe's amendment will be successful in the Full Committee, and since the funding for the solar and renewables is some $24 million above the budget baseline, the increase above the President's budget of $70 million, how do we accommodate—at the time when push comes to shove, how do we accommodate to that $23 million, $24 million increase, for example, with some probability that Mr. Wolpe's amendment won't pass?

Mr. **Wolpe**. There is some what?

Mr. **Ritter**. Probability that—there is some finite probability, in any event. I don't know how optimistic you are, but there is the finite probability that your amendment won't pass. How do we deal with this increase above and beyond the budget baseline?

Mr. **Scheuer**. It seems to me we can't anticipate what the full committee is going to do. We have to work at this.

Mr. **Wolpe**. I think the point that I would also underscore, there is no reason why this subcommittee should be penalized simply because we happen to have gone second in the markup phase, in the markup process. Basically these are the decisions. There will be trade-offs. I would like to see us achieve exactly what we are proposing here. We may not be able to hold every last number. I hope we can. But those are decisions that would have to be resolved in the full committee.

Mr. **Ritter**. I must admit that I am new to the energy allocations, and I am just willing to listen and learn as we go forth.

Thank you, Mr. Chairman. I yield back to the gentleman.

Mr. **Scheuer**. All right. Sid, do you have anything further?

Mr. **Morrison**. I yield back my time, Mr. Chairman.

Mr. **Scheuer**. Then it seems to me that the question is on the motion to report the bill. All in favor say aye.

[A chorus of ayes.]

Mr. **Scheuer**. All opposed say nay.

[No response.]

Mr. **Scheuer**. The ayes have it. The bill is reported to the full committee with the usual instructions.

Thank you all very much.

[Whereupon, at 2:42 p.m., the subcommittee was adjourned, to reconvene subject to the call of the Chair.]

MARKUP OF H.R. 2399, ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT AUTHORIZATION ACT OF 1991

WEDNESDAY, MAY 22, 1991

House of Representatives,
Committee on Science, Space, and Technology,
Washington, DC.

The committee met, pursuant to notice, at 10:27 a.m., in room 2318, Rayburn House Office Building, Hon. George E. Brown, Jr. (chairman of the committee) presiding.

The Chairman. The Committee will come to order.

Obviously, a lot of important business is still being transacted up here, but we need to move ahead.

This morning, the Committee will take up three authorization bills: H.R. 2282, the National Science Foundation Authorization Act Amendments of 1991; H.R. 2399, the Energy Technology Research and Development Authorization Act of 1991; and H.R. 2404, the Environmental Research, Development, and Demonstration Authorization Act of 1991.

After today's markup, the Committee will have completed its markups of all the major authorization bills. It's the first time in many years that the Committee has ordered reported all of its authorization bills before the Memorial Day recess. I think this is a noteworthy event, and I want to commend all of the Subcommittee Chairs and the Ranking Republican Members for their hard work in moving these bills through to the Full Committee in such a timely and cooperative fashion.

With these bills, we have also exercised budget discipline and met the commitment to set priorities and make hard decisions. Taken together, the funding in all of the Committee's authorization bills does not exceed the total funding requested in the President's budget for the agencies under this Committee's jurisdiction, and that also sets a record of sorts.

Setting priorities within the President's budget request has not been an easy task. Many of us can identify worthwhile programs which simply will not be funded at levels we believe are appropriate. There simply isn't enough money in the budget to do all that we can to bolster our economic competitiveness in the global high-technology market; to fund cutting-edge scientific research in a wide field of scientific disciplines; to explore space, the final frontier, to find new ways to use energy cleanly and wisely; and to protect and clean up our environment. As in any political process, we have made compromises, and while not everyone is happy about everything in all of our bills, I'm confident that most of the members share my view that we have arrived at an appropriate consensus on our science funding priorities as far, as we can determine at this time.

I want to commend all of the Members of the Committee on both sides for their efforts in this first-time effort to set some meaningful priorities for the programs under our jurisdiction.

I might add just briefly to that that there remain, of course, a few items which have not been fully resolved or worked out and, in fact, are in the process of being negotiated. We will try and defer including these in today's legislation until we have reached some sort of a consensus on it, and I intend, in that event, to bring these relatively small number of additional items to the floor as Chairman's amendments after we have had further negotiations on them. I make this as a good faith promise, and I hope that this will make some people, at least, a little less unhappy at the thought that they didn't get everything that they may have wanted in the legislation before us.

Now, let me at this point recognize our Ranking Minority Member, Mr. Walker, for any general remarks before we move to the first bill, which is the National Science Foundation Act.

Bob?

Mr. WALKER. Mr. Chairman, I don't have any real opening remarks. I prefer to move on to the NSF bill, where I will have some remarks.

[Immediately following consideration of H.R. 2282, the National Science Foundation Authorization Act Amendments of 1991, the Committee began its consideration of H.R. 2399.]

The CHAIRMAN. The next order of business is H.R. 2399, the Committee markup on the Energy Technology Research and Development Authorization Act of 1991.

[A copy of H.R. 2399 follows:]

I

102D CONGRESS
1ST SESSION

H. R. 2399

To authorize appropriations for research and development and demonstration activities of the Department of Energy for fiscal years 1992 and 1993, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

MAY 20, 1991

Mrs. LLOYD (for herself and Mr. MORRISON) introduced the following bill; which was referred to the Committee on Science, Space, and Technology

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A BILL

To authorize appropriations for research and development and demonstration activities of the Department of Energy for fiscal years 1992 and 1993, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Energy Technology Research and Development Authorization Act of 1991".

SEC. 2. FINDINGS.

The Congress finds that—

(1) the development of new energy technologies is a necessary step in reducing oil imports and providing for our Nation's energy needs in the 21st century;

(2) the development of efficient, economic, safe, and environmentally acceptable energy technologies is a necessary part of an effective National Energy Strategy;

(3) technological advances in the recovery and use of our fossil fuel resources will provide time for an orderly transition to other energy sources while at the same time reducing our vulnerability to supply disruptions, price escalations, and the environmental side effects of fossil fuel use; and

(4) technology development occurs over a time span that is often measured in years or even decades, therefore, commitments to new energy technology development must be consistent with those time requirements and cannot be made on a year-to-year basis.

SEC. 3. DEFINITIONS.

For purposes of this Act—

(1) the term "major construction project" means a project whose construction costs are esti-

mated to exceed $100,000,000 over the life of the project;

(2) the term "Secretary" means the Secretary of Energy; and

(3) the term "substantial construction project" means a project whose construction costs are estimated to exceed $10,000,000, but not to exceed $100,000,000, over the life of the project;

SEC. 4. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary the following amounts:

(1) Supporting Research and Technical Analysis—

(A) Basic Energy Sciences Program—

(i) $714,700,000 for fiscal year 1992, of which $6,300,000 shall be for completion of construction of the Advanced Light Source and $90,400,000 shall be for construction of the Advanced Photon Source;

(ii) $836,500,000 for operating, capital equipment, and construction for fiscal year 1993, of which $437,600,000 shall be for research activities, $196,000,000 shall be for the operation of user facilities, $112,500,000 shall be for construction of the Advanced Photon Source, and $38,900,000 shall be for construction of the Advanced Neutron Source;

(iii) $93,000,000 for fiscal year 1994 shall be for construction of the Advanced Photon Source; and

(iv) $45,000,000 for fiscal year 1995 shall be for completion of the construction of the Advanced Photon Source;

(B) Energy Research Analysis Program, $4,000,000 for fiscal year 1992, and $4,200,000 for fiscal year 1993;

(C) Multiprogram Energy Laboratories Facilities Support Program, $23,900,000 for fiscal year 1992, and $24,900,000 for fiscal year 1993;

(D) University and Science Education, $57,500,000 for fiscal year 1992, and $72,900,000 for fiscal year 1993; and

(E) Advisory and Oversight Program Direction and Policy Management for Energy Research activities, $10,100,000 for fiscal year 1992, and $10,500,000 for fiscal year 1993.

(2) Nuclear Energy—

(A) Nuclear Energy Research and Development Program, $391,000,000 for fiscal year 1992, and $420,000,000 for fiscal year 1993, including—

(i) Certification of Light Water Reactor Designs, $44,500,000, for fiscal year 1992, of which $2,000,000 shall be for first-of-a-kind engineering for initiating the first standardized commercial nuclear power plant, and $62,500,000 for fiscal year 1993, of which $20,000,000 shall be for first-of-a-kind engineering for initiating the first standardized commercial nuclear power plant;

(ii) Advanced Reactor Research and Development, $60,500,000 for fiscal year 1992, and $73,000,000 for fiscal year 1993;

(iii) Space Reactor Power Systems, $36,000,000 for fiscal year 1992, and $36,500,000 for fiscal year 1993;

(iv) Advanced Radioisotope Power, $56,000,000 for fiscal year 1992, and $58,000,000 for fiscal year 1993;

(v) Space Exploration Initiative, $5,000,000 for fiscal year 1992, and $5,000,000 for fiscal year 1993;

(vi) Facilities Support, including operations, capital equipment, and general plant construction, $178,800,000 for fiscal year 1992, of which $79,000,000 shall be for the Fast Flux Test Facility, and $168,800,000 for fiscal year 1993, of which $69,000,000 shall be for the Fast Flux Test Facility; and

(vii) Program Direction, Nuclear Energy, $10,200,000 for fiscal year 1992, and $16,200,000 for fiscal year 1993; and

(B) For developing and conducting an integrated research and development program to explore new technologies for reducing, treating, transmuting, separating, recycling, storing, or otherwise mitigating hazards associated with high level radioactive waste and spent fuel from nuclear reactors, $8,000,000 for fiscal year 1992, and $8,320,000 for fiscal year 1993.

(3) Fusion Energy Research and Development—

(A) Magnetic Fusion Energy Research, including operating activities, program direction, capital equipment, and construction activity—

(i) $328,900,000 for fiscal year 1992, of which—

(I) $30,000,000 shall be for preconstruction activities of the Burning Plasma Experiment facility; and

(II) $41,800,000 shall be for the Engineering Design Activity of the International Thermonuclear Engineering Reactor; and

(ii) $387,000,000 for fiscal year 1993, of which $35,400,000 shall be for construction of the Burning Plasma Experiment facility; and

(B) Inertial Confinement Fusion Program, $8,200,000 for fiscal year 1992, and $14,000,000 for fiscal year 1993.

(4) Atomic Vapor Laser Isotope Separation Program—

(A) $228,600,000 for fiscal year 1992, of which—

(i) $219,300,000 shall be for operations, including $20,000,000 for procurement of a commercial deployment contractor and a predeployment assessment of the demonstration of Atomic Vapor Laser Isotope Separation technology and the preparation of a report to the Congress, to be submitted within 90 days after completion of such demonstration, on the economic market, financing, and risk assessment for commercial deployment of such technology;

(ii) $6,100,000 shall be for capital equipment; and

(iii) $3,200,000 shall be for construction; and

(B) $225,800,000 for fiscal year 1993.

(5) Environmental Restoration and Waste Management Program, for corrective activities, environmental restoration, waste management, and related technology development for civilian programs and activities of the Department of Energy, $523,500,000 for fiscal year 1992, and $594,200,000 for fiscal year 1993.

(6) Fossil energy—

(A) $471,000,000 for fiscal year 1992, of which—

(i) $206,000,000 shall be for Basic and Supporting Research, including Control Technology and Coal Preparation, Advanced Research and Technology Development, Coal Liquefaction, Combustion Systems, Heat Engines, Underground Coal Gasification, and Surface Coal Gasification;

(ii) $89,000,000 shall be for Advanced Technology Development, including $48,000,000 for Fuel Cells, and $41,000,000 for Magnetohydrodynamics;

(iii) $70,000,000 shall be for Petroleum;

(iv) $23,000,000 shall be for Natural Gas;

(v) $6,000,000 shall be for Cooperative Research and Development; and

(vi) $77,000,000 shall be for Supporting Activities, including Program Direction and Management Support, Environmental Restoration, and Plant and Capital Equipment; and

(B) $507,000,000 for fiscal year 1993, of which—

(i) $214,000,000 shall be for Basic and Supporting Research, including Control Technology and Coal Preparation, Advanced Research and Technology Development, Coal Liquefaction, Combustion Systems, Heat Engines, Underground Coal Gasification, and Surface Coal Gasification;

(ii) $88,000,000 shall be for Advanced Technology Development, including $60,000,000 for Fuel Cells, and $28,000,000 for Magnetohydrodynamics;

(iii) $90,000,000 shall be for Petroleum;

(iv) $26,000,000 shall be for Natural Gas;

(v) $7,000,000 shall be for Cooperative Research and Development; and

(vi) $82,000,000 shall be for Supporting Activities, including Program Direction and Management Support, Environmental Restoration, and Plant and Capital Equipment.

SEC. 5. MAJOR CONSTRUCTION POLICY.

(a) STATEMENT OF POLICY.—(1) It shall be the policy of the United States, with respect to substantial construction projects of the Department of Energy in civilian energy research and development areas, to authorize appropriations for the life of such substantial construction projects when the projects are initially authorized.

(2) It shall be the policy of the United States, with respect to major construction projects of the Department of Energy in civilian energy research and development areas, to authorize appropriations for the life of such major construction projects when the preliminary design phase is completed and appropriate information is provided to the Congress with respect to anticipated costs and schedules.

(b) REPORT TO CONGRESS.—The Secretary shall, after completion of the preliminary design phase of a major construction project, submit to the Congress a report containing—

(1) an estimate of the total cost of construction of the facility;

(2) an estimate of the time required to complete construction;

(3) an estimate of the annual operating costs of the facility;

(4) the intended useful operating life of the facility; and

(5) an identification of any existing facilities to be closed as a result of the operation of the facility.

SEC. 6. ADVANCED NEUTRON SOURCE AND BURNING PLASMA EXPERIMENT MAJOR CONSTRUCTION REPORTS.

The Secretary shall, within 120 days after the date of completion of the preliminary design phase of the Advanced Neutron Source major construction project, and of the Burning Plasma Experiment major construction project, provide the Congress with information on their anticipated cost and schedule with respect to each such project, to enable the Congress to consider authorization of each such project in its entirety as a major construction project.

SEC. 7. ATOMIC VAPOR LASER ISOTOPE SEPARATION.

(a) DEPLOYMENT CONTRACTOR.—The Secretary shall proceed expeditiously to procure a deployment contractor for the commercialization of the Atomic Vapor Laser Isotope Separation technology.

(b) IDENTIFICATION OF ALTERNATIVE APPLICATIONS.—The Secretary shall authorize the University of California and Martin Marietta Energy Systems, Inc. to enter into cooperative research and development agreements with private sector entities to identify and develop non-uranium enrichment applications of the Atomic Vapor Laser Isotope Separation technologies.

SEC. 8. STANDARDIZED COMMERCIAL NUCLEAR POWER PLANT.

(a) AWARD OF CONTRACT.—The Secretary shall award a contract for further design and engineering with respect to a standardized commercial nuclear power plant design that has been certified by the Nuclear Regulatory Commission.

(b) SELECTION CRITERIA.—The Secretary shall award the contract under subsection (a) to an entity that certifies to the satisfaction of the Secretary that—

(1) the plant will be constructed in the United States;

(2) at least 75 percent of all design, engineering, manufacture, and construction activities in connection with the plant shall be performed in the United States;

(3) the entity is a bona fide entity normally engaged in the design, engineering, manufacture, and construction of nuclear reactors;

(4) the entity has entered into a binding agreement for construction of a nuclear power plant with a utility or private entity whose primary purpose is

the production of electrical power for public consumption; and

(5) the entity has the financial resources necessary, and fully intends, to pursue the design, engineering, manufacture, and construction of a full-scale nuclear power plant of at least 600 MWe in size through completion of construction and into operation.

(c) FUNDING.—The project described in this section shall receive at least 50 percent of its funding from non-Federal sources. Federal funding for such project shall not exceed $20,000,000 for each fiscal year, and the total of Federal funding over the course of such project shall not exceed $60,000,000.

SEC. 9. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES.

The Secretary shall, within 6 months after the date of enactment of this Act, submit to the Congress a report outlining plans for increasing the participation of historically black colleges and universities in the Basic Energy Science programs of the Department of Energy.

SEC. 10. RESEARCH REACTOR USER COMPLEX.

(a) PURPOSE.—The purpose of this section is to establish the Fast Flux Test Facility as a multi-mission center for the purpose of conducting research and development on isotopes and energy, to be operated by the Department of Energy in partnership with international and domestic user organizations.

(b) ESTABLISHMENT.—Not later than 90 days after the date of enactment of this Act, the Secretary shall establish a research, development, and production center at the Hanford Reservation in Richland, Washington, to be known as the "Research Reactor User Complex" (hereafter in this section referred to as the "RRC").

(c) AGREEMENTS; AUTHORIZED USES.—In establishing the RRC, the Secretary shall provide that the Department of Energy, and any contractors under contract with the Department of Energy to operate the RRC, may enter into agreements with non-Federal entities (including foreign governments and foreign entities) or a consortium of such entities to use the RRC for any of the following purposes:

(1) The production of industrial and medical isotopes for use or sale, or both, by the non-Federal entities who have entered into the agreement.

(2) Irradiation services to support research or commercial objectives, or both.

(3) The production of steam to be used or sold, or both, by the non-Federal entities who have entered into the agreement.

(d) CHARGES.—The Secretary may assess such charges from non-Federal entities under an agreement entered into pursuant to subsection (c) as the Secretary determines may be necessary or appropriate to implement the purpose of this section.

(e) PERIOD OF AGREEMENT.—The Secretary shall not enter into an agreement pursuant to subsection (c) for a period of time exceeding 25 years.

(f) TERMINATION PROVISIONS.—(1) Under an agreement entered into pursuant to subsection (c), the Secretary may include a termination provision that requires the Department of Energy to pay for the unamortized balance of any special facilities acquired or constructed by the non-Federal entities who have entered into the agreement if—

(A) the RRC is shut down for lack of Federal appropriations; and

(B) the acquisition or construction of the special facilities constitutes a significant portion of the investment by the non-Federal entities under the agreement.

(2) A termination provision described in paragraph (1) may authorize the use, for the purpose of paying such unamortized balance and any other costs resulting from termination, of any Federal funds available for operating expenses pursuant to subsection (j)(2).

(3) For purposes of this subsection, the term "special facilities" means any depreciable buildings, structures, utilities, machinery, equipment, materials, or services not made available to non-Federal entities by the Department of Energy.

(g) OTHER AGREEMENT PROVISIONS.—Under an agreement entered into pursuant to subsection (c), the Secretary may—

(1) make available to non-Federal entities facilities, equipment, utility services, fire protection, and other similar services;

(2) lease real or personal property to non-Federal entities to carry out the purpose of this section;

(3) include an appropriate indemnification pursuant to section 170 d. of the Atomic Energy Act of 1954 (42 U.S.C. 2210); and

(4) include such other terms and conditions as the Secretary determines will implement the purpose of this section.

(h) COMPETITIVE PROCEDURES.—In entering into a contract with a non-Federal entity pursuant to subsection (c), the Secretary may use procedures other than competitive procedures as described in section 303 of the Federal Property and Administrative Services Act of 1949 (41 U.S.C. 253).

(i) PROVISIONS RELATING TO DEPARTMENT OF ENERGY CONTRACTOR.—A contractor under contract with the Department of Energy to operate the RRC shall—

(1) maintain and operate the Fast Flux Text Facility under contract with and for the account of the Department of Energy pursuant to section 110 of the Atomic Energy Act of 1954 (42 U.S.C. 2140);

(2) ensure that all experiments meet applicable safety requirements and acceptable criteria; and

(3) provide necessary support services to the non-Federal entities that have entered into agreements pursuant to subsection (c).

(j) RRC FUND.—(1) There is established in the Treasury of the United States a separate fund to be known as the "RRC Fund". The RRC Fund shall consist of all amounts received by the Secretary from charges assessed under subsection (d).

(2) Subject to appropriations, the Secretary may make expenditures from the RRC Fund each fiscal year to offset the cost of operating the RRC in such fiscal year. Amounts in the RRC Fund not needed for operations shall be invested in United States securities, the proceeds of which shall accrue to the RRC Fund.

SEC. 11. COST SHARING GUIDELINES.

The Secretary shall conduct a study of the appropriateness of cost sharing requirements for fossil research and development projects of the Department of Energy, taking into account the type of project and costs required for completion. Within 6 months after the date of enactment of this Act, the Secretary shall submit to the Congress a report containing the results of such study, along with proposed guidelines for cost sharing with respect to such projects, including provisions regarding the use of data, rights of parties, and ownership of the research results or technologies developed.

SEC. 12. ANNUAL BUDGET SUBMISSION.

The Secretary shall annually submit to Congress, along with the President's budget request, a 3-year budget estimate for the civilian research and development programs of the Department of Energy, including funding estimates for each major account and new initiative.

SEC. 13. AUTHORIZATION RESTRICTION.

Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program for which funding was requested in an annual budget request of the President but for which the Congress declined to authorize funding; and

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount authorized for that program under this Act.

○

The CHAIRMAN. Let me make a comment with regard to this. I think all of us are aware that it's been some time since this committee has passed an authorization bill for energy R&D. I want to recognize and praise the diligence of both Chairman Lloyd and Chairman Scheuer in moving to report responsible packages out of their respective subcommittees. We have made some minor adjustments in the subcommittee funding recommendations in order to accommodate our wish to bring the overall total authorization within the budget limit requested by the President.

I believe that we have in this markup vehicle a fiscally responsible approach to balancing a very complex set of program needs. The fiscal constraints within which we are operating make worthy programs compete for limited funding. This authorization bill recognizes those constraints.

We are proposing to strengthen the Energy Conservation and Renewable Energy Research Programs. The Administration's national energy strategy documents acknowledge the importance of strengthening conservation and renewable energy R&D. Unfortunately, the amount included in the President's request was not sufficient, and the budget request of the Administration did not reflect the importance of these two areas.

Improving our energy efficiency and developing new high-efficiency technology is absolutely fundamental to meeting America's future energy needs in an economical and environmentally sound manner. Greater energy efficiency, along with expediting the development and deployment of energy supply technologies based on renewable energy resources, is essential for maintaining our international economic competitiveness. Beyond that, energy efficiency and renewable energy are essential for moving us in the direction of an environmentally sustainable future.

I didn't realize I had such a long opening statement here. [Laughter.]

I ask unanimous consent that the remainder of my opening statement be included in the record at this point, and I will have an amendment which I will offer later, and I will explain it at that point.

May I just say in a general fashion that I'm not totally satisfied with this bill. It does not completely authorize all of the energy programs that I think this committee ought to be authorizing, but we're going to take it a step at a time. We're going to do the best we can this year, and we'll come back and do even better next year if we are able to do so, and I regard this bill before us as a very significant step in the proper direction for this committee.

Mr. Walker?

[The prepared statement of Mr. Brown follows:]

THE HONORABLE GEORGE E. BROWN, JR.

OPENING STATEMENT

MAY 22, 1991

FULL COMMITTEE MARK-UP OF THE ENERGY TECHNOLOGY RESEARCH AND DEVELOPMENT AUTHORIZATION ACT OF 1991

Today we have before us for Committee Mark-Up the Energy Technology Research and Development Authorization Act of 1991, the authorization for the Department of Energy's Civilian Research and Development Programs.

As you know, it has been some time since this Committee has passed an authorization bill for Energy R&D. I want to recognize and praise the diligence of Chairman Scheuer and Chairman Lloyd in moving to report responsible packages out of their respective Subcommittees.

We have made some minor adjustments in the Subcommittee funding recommendations, in order to accommodate our wish to bring the overall total authorization within the budget limit requested by the President.

I believe that we have in this mark-up vehicle a fiscally responsible approach to balancing a very complex set of program needs. The fiscal constraints within which we are operating make worthy programs compete for limited funding. This authorization bill recognizes these constraints.

We are proposing to strengthen the energy conservation and renewable energy research programs. The Administration's National Energy Strategy document acknowledges the importance of strengthening conservation and renewable energy R&D. Unfortunately, the Administration's rhetoric was not sufficiently reflected in the Department of Energy's R&D budget request.

Improving our energy efficiency and developing new high-efficiency technologies is absolutely fundamental to meeting America's future energy needs in an economical and environmentally sound manner. Greater energy efficiency, along with expediting the development and deployment of energy-supply technologies based on renewable energy resources is essential for maintaining our international economic competitiveness. Beyond that, energy efficiency and renewable energy are essential for moving us in the direction of an environmentally sustainable energy future.

The substitute amendment I am offering supports the development of alternative fuels and vehicles to reduce our near-total dependence on oil in the transportation sector. The development of these alternatives, including electric vehicles, will enhance the nation's energy security and provide significant environmental benefits.

The amendment also contains support for furthering the development of technologies to enhance the production of our domestic fossil fuel resources. This is consistent with the goals expressed in the Administration's National Energy Strategy.

The amendment supports the development of technologies to enhance our ability to use our domestic resource base of coal in a more environmentally acceptable manner. It specifies an accelerated program for enhanced oil recovery to increase production from domestic reserves and increased efforts for the production and applications of natural gas. These technologies are crucial to meeting our future needs for energy supply and will enhance our energy security by reducing our reliance on imported oil.

The amendment provides support for nuclear energy research and development based on the potential of these advanced nuclear energy technologies for meeting future electricity generating needs. The amendment contains a provision for the "AVLIS" development program -- the Atomic Vapor Laser Isotope Separation uranium enrichment technology that DOE has developed. The goal of this program is to develop and demonstrate a cost-effective method for enriching uranium. This new technology is believed to have the potential to be significantly more economically competitive than the current technology based on gaseous diffusion.

The amendment provides for an assessment of its economic competitiveness and design effectiveness for commercial operation, to expedite the transfer of the AVLIS from the DOE laboratories to the private sector.

We must note that, at this time, nuclear power is facing major hurdles relating both to economics and to unresolved technical and policy issues, including the problems associated with waste management and disposal. The amendment provides funding for research and development related to nuclear waste, which is one of the most difficult challenges to nuclear power, and one for which we have not previously addressed with a coordinated R&D program.

Finally, the amendment supports the DOE request for the fusion energy program, and authorizes funding to continue operation of the Fast Flux Test Facility.

The proposed R&D authorizations we are considering today begin to reflect the directions in which I believe this country needs to move. We need to rebuild the energy conservation and renewable energy programs.

Between fiscal 1979 and fiscal 1989, funding for DOE'S energy conservation R&D programs was cut by 70% in real terms. Since 1989 there has been a moderate reversal of this short-sighted policy of cutting energy efficiency research, but the strengthening we are proposing in this bill still restores just a fraction of what was cut during the Reagan Administration.

There is a tremendous untapped potential for making energy efficiency gains and developing new high-efficiency technologies in every key sector of the U.S. economy. While progress has been made since the days of the oil embargo and the energy price shocks of the 1970s, there is still a long way to go -- in our industrial manufacturing, in the transportation sector, and in residential and commercial buildings. Our European and Japanese trading partners tend to be more competitive in this respect -- they use much less energy to produce a unit of gross national product. This puts the United States at a competitive disadvantage.

Renewable energy R&D fared even worse during the 1980s.

Between 1979 and 1990 renewable energy programs were virtually gutted -- cut by 90% in real terms. Yet, in spite of this misguided trend, renewable energy has made significant progress in technological sophistication and cost reductions.

Now, as the world market for renewable energy is growing, a number of our trading partners, including Germany and Japan, are investing significantly greater shares of their energy research and development budgets in these technologies -- solar photovoltaics, wind energy, hydrogen, and so forth. While we have achieved a technological leadership position, we are in danger of letting our lead slip away and losing our competitive position.

How we produce and use energy is of fundamental importance for the strength of our economy, the security of our energy supply, the quality of our environment, and the legacy we pass on to future generations. Our energy programs of federally supported scientific research, technology development, and public-private sector cooperative demonstration projects to speed commercialization, are all essential to meeting these future needs.

Mr. **Walker**. Mr. Chairman, the legislation this Committee is being asked by its Subcommittees to support is $356 million over President Bush's request to implement a National Energy Strategy. Now, maybe more money makes for a better strategy, and I appreciate the desire of this Committee to accelerate research and development. But, what I don't understand is why, if we can come up with $356 million over the budget, we end up cutting over $100 million of Department of Energy priorities, in particular, the President's own manned-space exploration initiative. At a time when this Committee's integrity and relevance are being so blatantly challenged by the appropriators, it seems to me that we should be resolute and firm in our support of the United States' future in space.

In that regard, Mr. Chairman, in an effort to support this bill, I look forward to working with you to restore some initiatives on the floor which will allow the Department of Energy to support our future electrical energy needs and fulfill its existing obligations and commitments to other agencies. The Department of Energy is pleading for our support, and they deserve our leadership.

Thank you, Mr. Chairman.

The **Chairman**. I appreciate the gentleman's remarks, and I have assured him privately and I will assure him publicly that we will continue to seek to make additional changes in this bill which will bring it closer to the views that he has expressed, and I am confident that we'll be able to do that.

The Chair recognizes the Chairman of the Environmental Subcommittee, Mr. Scheuer, for his portion of the Subcommittee report on this bill.

Mr. **Scheuer**. Thank you, Mr. Chairman.

Mr. Chairman, I wish to commend you most heartily for structuring a comprehensive and fiscally responsible legislative proposal for the Committee's programs within the Department of Energy's energy supply research and development accounts. The substitute amendment before the members takes a strong position with regard to the level of investment our Nation must make in conservation and in renewable energy if our energy supply portfolio is to remain strong.

The National Academy of Sciences, in its recent report confronting climate change, says that expenditures for technologies based on solar and renewable sources and energy efficiency should account for 20 percent of the Nation's energy supply R&D budget. The Administration's fiscal year 1992 request for these programs represents only a 13 percent share. The Brown amendment redresses that inequity by increasing funding for those programs.

Committee members should note that many of the technologies represented on the White House list of 22 technologies deemed critical to U.S. competitiveness are represented in this budget. They include ceramics composites, energy technologies, pollution and waste minimization, surface transportation, materials synthesis and processing, high-performance metals, applied molecular biology, and medical technology.

Mr. Chairman, I look forward to working with you to bring this excellent energy package to the House floor.

The CHAIRMAN. The Chair thanks the gentleman from New York for his comments and recognizes the ranking Republican member of that subcommittee, Mr. Ritter.

Mr. RITTER. Thanks, Mr. Chairman.

I want to commend you and the Subcommittee Chairman, Mr. Scheuer, and Mrs. Lloyd, as well as Mr. Walker and Mr. Morrison, the Ranking Republican on the Energy Subcommittee, for your efforts in assembling this energy authorization.

The bill is a concrete step toward development of a responsible, fiscally—and environmentally—sound energy strategy to help decrease our Nation's reliance on imported oil. And, I am also of the belief that prudent energy conservation provides for more efficient use of all of our resources and has a signal effect on our Nation's economic well-being and competitiveness. Conservation pays, basically.

The bill before us today recognizes that no one single technology is going to be the answer to our energy dilemma. And, we need to focus our R&D efforts on a mix of resources that can be harnessed in an efficient, productive, and environmentally acceptable manner. The bill proposes funding for programs which are essential components for this mix.

The Environment Subcommittee took action to restore funding toward levels of the early 1980's in programs within its jurisdiction, including R&D, to reduce uncertainties associated with renewable energy and move forward toward greater use of these resources in R&D in energy conservation and greater energy efficiency. As the President's National Energy Strategy notes, conservation efforts are especially beneficial. They enable us to make better use of the energy we already have, thus reducing energy costs to consumers and making industry more competitive, while helping us as a nation to break away from our great appetite for energy—sometimes dangerous appetite, I might add.

One promising conservation effort is the Metals Initiative, encompassing R&D efforts to save energy in the steel and aluminum industries. Once again, energy efficiency goes hand in hand with economic competitiveness and environmental quality.

Mr. Chairman, I support an energy R&D portfolio which features enhanced renewables and conservation programs. I also support measures taken by the Energy Subcommittee to fund R&D in promising energy technologies, including an enhanced effort to develop advanced, standardized nuclear reactors. Nuclear power has enormous potential to be a safe, clean, and abundant source of energy.

Mr. Chairman and my colleagues, you know that the nuclear option is on its way back when the only announced candidate for the Democratic nomination for the Presidency is supporting nuclear power and is running on a pro-nuclear power platform. Perhaps, this can help to allay some of the public concerns with nuclear energy.

Mr. Chairman, I look forward to working with you in moving forward this package toward consideration by the full House.

I also want to associate myself with the Comments made by the Ranking Member on propulsion systems for extended space exploration and hope that we can work out the appropriate language on the way to the floor of the House.

I yield back the balance of my time.

The **Chairman**. Thank you very much.

The Chair now recognizes the gentlelady from Tennessee, Mrs. Lloyd.

Mrs. **Lloyd**. Thank you very much, Mr. Chairman.

I, too, want to take this opportunity to thank you, Chairman Brown, for your leadership as well as your statesmanship in bringing this energy technology research and development bill before this Full Committee. Indeed, this is a great day for the Committee, and, as you stated earlier, it's a great step forward. We realized that there would be some adjustments that would have to be made when two energy bills were combined or married and reported for the Full Committee, and I do commend you, Mr. Brown, for making these adjustments as well as we have. It certainly look diplomacy on your part to bring about this consensus, and you've clearly displayed a wisdom of Solomon.

I do believe the Subcommittees on Energy and Environment have presented the Committee with a responsible proposal—not perfect, but it is responsible—because the energy bill that we have before us today has balance. We've provided strong foundations for the R&D programs for conservation, for renewables, for fossil, as well as nuclear, and all of these technologies must be pursued if we're going to achieve a broad-based energy mix that will help us to meet the challenges of the coming 21st century.

We on the Science Committee know full well that one can never predict where the next great development will come from, and so with that knowledge, we must steadfastly pursue all of the reasonable opportunities that we have for energy research and development.

I thank you, Mr. Chairman.

The **Chairman**. The Chair recognizes the gentleman from Washington, Mr. Morrison.

Mr. **Morrison**. Thank you, Mr. Chairman.

It's interesting as we have gone through this authorization markup process that the budget agreement really does bring fiscal arguments down to the Subcommittee level more than many of us are used to. And, so, I want to add my voice and thanks to our Chairman and certainly to my Subcommittee Chairman, Mrs. Lloyd, for an excellent balancing act.

These Subcommittee reports do reflect the personality of the Subcommittees, and, yet, I like to think as we bring you the energy report that it is blended with the real energy world's needs. We've made every effort to do that.

I also thank Chairman Brown because he will be offering a substitute as part of this discussion that further refines our efforts to bring the two Subcommittees represented here, both Environment and Energy, together.

I also would point out we still have some details to work out reflecting some vital concerns of the Department of Energy, some of their priorities, and I'll have more to say about that when we get into the section dealing with amendments.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much, Mr. Morrison.

Now, for a second opinion, the Chair recognizes Mr. Wolpe. [Laughter.]

Mr. WOLPE. Thank you very much, Mr. Chairman.

I was going to begin by also commending you on your extraordinary accomplishment this year in putting together the substitute that you'll be offering in just a moment.

As you know, I was prepared to offer a major amendment to the DOE authorization bill before us. I was concerned that the final bill reported from the committee would contain huge increases in nuclear energy research and development at the expense of energy efficiency and renewable energy programs. However, I'd like to indicate my support for the Chairman's substitute that we will be considering in a moment. In my view, it is a step toward a more balanced and rational energy research and development policy, and by agreeing to support the Chairman's alternative, I will be refraining from offering any amendments to this package.

I would, however, like to reserve the option to offer amendments to this package at some future date. My concerns center in particular on the Advanced Nuclear Program, the AVLIS Program, the SP100 Program, and the Reduced Enrichment Research and Test Reactor Program. While this bill is a step in the right direction, I believe that we still have a long way to go. We're in the midst of a period of severe fiscal constraints and increased concern about energy security. This situation demands fiscal discipline, and with such limited resources, we simply can't tolerate research and development spending that lacks merit.

I submit that we should be making some effort to systematically match energy research and development spending with national energy goals. While this makes simple common sense, it's not the way our Government generally operates. From my experience, priorities are more typically established not by employing objective criteria or measurements of evaluation, but in response to parochial concerns or special interest pressures.

The nuclear energy research and development budget is the best example of this disparity between stated energy policy goals and actual R&D spending priorities. This can be seen by taking a look at the Administration's own national energy strategy. The chapter entitled "Enhanced Research and Development for Energy Security" begins with this passage, and I quote:

> One of the keys to ensuring future energy security is reducing U.S. oil vulnerability. Technological advancements are one of the best ways to achieve this. The national energy strategy calls for increasing investments for technology research and development in the areas with the greatest potential for reducing oil vulnerability.

I could not agree more, but if you take a closer look at the Administration's priorities for enhanced R&D, you'll notice that the largest chunk, approximately $1.2 billion over the next five years, would be spent in two nuclear energy R&D programs. I asked the Department of Energy to indicate how much oil would be displaced by each of the Administration's 12 enhanced energy R&D initiatives, and this is the response of the Department:

> The two nuclear options reports in the President's budget are not included, because no oil savings are expected from these options since little oil is used in electricity generation now, and even less oil use is expected in the future.

While the Administration claims that we should be increasing investments in areas with the greatest potential for reducing oil vulnerability, their own analysis indicates that their top energy R&D priorities will not displace any petroleum whatsoever. I'm forced to conclude that the Administration is less concerned with energy security than rescuing a dying industry. The Administration's own best case projections indicate that if it were left to market forces, nuclear power plants would cease to produce any energy in America in the year 2030.

During a hearing of the Energy Subcommittee, I asked the Assistant Secretary for Nuclear Programs why the Administration was targeting such huge sums to nuclear R&D. He replied that such support was necessary so that nuclear energy could compete on a level playing field with other technologies. In light of the billions of dollars in Federal subsidies lavished upon the nuclear industry since the Atoms for Peace Program, that was a truly astounding observation.

When pressed further to justify the National Energy Strategy's heavy emphasis on nuclear energy, the Assistant Secretary indicated that they had documentation to indicate what they had argued in their National Energy Strategy statement. Despite repeated requests, however, I have yet to receive any data from the Department of Energy justifying their decision to make the resuscitation of the nuclear industry one of the primary objectives of the National Energy Strategy. Thank you.

The CHAIRMAN. The Chair appreciates the comments of the gentleman and recognizes the great deal of work that he's done in analyzing this problem. It will be a major issue before this committee for some time, determining the proper role of the various energy strategies, and I indicated in my own opening remarks that I'm not fully satisfied with all of the details of this, but I am convinced that we are taking a strong step in the right direction, and I want to encourage us to continue in that direction.

Are there additional comments before we have a motion to adopt the committee report?

[No response.]

The CHAIRMAN. If not, a motion is in order to adopt the committee report.

Mr. RITTER. Mr. Chairman.

The CHAIRMAN. Mr. Ritter.

Mr. RITTER. Mr. Chairman, I move the adoption of the reports of the Subcommittee on Energy and the Subcommittee on Environment on H.R. 2399, the Energy Technology Research and Development Act of 1991.

The CHAIRMAN. You have heard the motion. All those in favor of the motion, signify by saying aye.

[Chorus of ayes.]

The CHAIRMAN. Opposed, no.

[No response.]

The CHAIRMAN. The ayes have it, and the bill is open for discussion at any point.

Do any additional members care to make any comments with regard to the bill before we entertain amendments?

[No response.]

The CHAIRMAN. If not, the bill is open for amendments at any point, and the Chair would like to make a statement.

The Chair offers an amendment in the nature of a substitute and asks unanimous consent that the text of the substitute be considered as original text for the purpose of markup.

The substitute I'm offering today combines the bills reported by both the Energy Committee and the Environment Subcommittee and makes a number of reductions in funding reported by the Subcommittees. The reductions were required in order to keep the total funding authorized by the Committee for agencies under its jurisdiction from exceeding the President's budget request.

The substitute retains the programs and fundings reported by both subcommittees, with the following exceptions: funding for the Fast Flux Test Facility will come from the restoration and waste management account, where it was located last year, rather than from the nuclear R&D account; the levels of increased funding proposed for renewables, for AVLIS, and for conservation have been reduced from those reported, although all will enjoy substantial increases over 1991; and the supporting research and technology programs have been reduced by $3.5 million. Funding for the space exploration initiative has been increased by $10 million, as well as the SP100 Space Reactor Program, and I want to commend both Mr. Stallings and Mr. Walker for their efforts to increase funding for these programs. While I don't think either one of the gentlemen are completely satisfied, we will continue to discuss this matter with them with the possibility of entertaining an additional amendment on the floor when we get to that point.

While we could not meet everyone's desire in this substitute and, given the spread of political viewpoints on this committee, could not have done so even with an unlimited budget, we believe the substitute reflects a balanced, progressive program for enhancing our energy security, assuring economic growth and protecting the environment. I'm sure that the amendment I'm offering is an excellent amendment, in other words.

[The amendment proposed by the Chairman follows:]

Schort 1 ✓ (a)

BROWCA030

HR 2399

Adopted, as amended, voice vote

AMENDMENT IN THE NATURE OF A SUBSTITUTE
OFFERED BY MR. BROWN

Strike all after the enacting clause and insert in lieu thereof the following:

SECTION 1. SHORT TITLE.

This Act may be cited as the ``Energy Technology Research and Development Authorization Act of 1991''.

SEC. 2. FINDINGS.

The Congress finds that--

(1) the development of new energy technologies is a necessary step in reducing oil imports and providing for our Nation's energy needs in the 21st century;

(2) the development of efficient, economic, safe, and environmentally acceptable energy technologies is a necessary part of an effective National Energy Strategy;

(3) technologies to improve energy efficiency and utilize renewable energy resources offer significant opportunities to meet energy and environmental goals;

(4) technological advances in the recovery and use of our fossil fuel resources will provide time for an orderly transition to other energy sources while at the same time reducing our vulnerability to supply

disruptions, price escalations, and the environmental side effects of fossil fuel use; and

(5) technology development occurs over a time span that is often measured in years or even decades, therefore, commitments to new energy technology development must be consistent with those time requirements and cannot be made on a year-to-year basis.

SEC. 3. DEFINITIONS.

For purposes of this Act--

(1) the term ``major construction project'' means a project whose construction costs are estimated to exceed $100,000,000 over the life of the project;

(2) the term ``Secretary'' means the Secretary of Energy; and

(3) the term ``substantial construction project'' means a project whose construction costs are estimated to exceed $10,000,000, but not to exceed $100,000,000, over the life of the project;

SEC. 4. AUTHORIZATION OF APPROPRIATIONS.

(a) Supporting Research and Technical Analysis.--There are authorized to be appropriated to the Secretary, for Supporting Research and Technical Analysis, the following amounts:

(1) Basic Energy Sciences Program--

(A) $714,700,000 for fiscal year 1992, of which

$6,300,000 shall be for completion of construction of the Advanced Light Source and $90,400,000 shall be for construction of the Advanced Photon Source;

(B) $836,500,000 for operating, capital equipment, and construction for fiscal year 1993, of which $437,600,000 shall be for research activities, $196,000,000 shall be for the operation of user facilities, $112,500,000 shall be for construction of the Advanced Photon Source, and $38,900,000 shall be for construction of the Advanced Neutron Source;

(C) $93,000,000 for fiscal year 1994 shall be for construction of the Advanced Photon Source; and

(D) $45,000,000 for fiscal year 1995 shall be for completion of the construction of the Advanced Photon Source;

(2) Energy Research Analysis Program, $4,000,000 for fiscal year 1992, and $4,200,000 for fiscal year 1993;

(3) Multiprogram Energy Laboratories Facilities Support program, $23,900,000 for fiscal year 1992, and $24,900,000 for fiscal year 1993;

(4) University and Science Education, $57,500,000 for fiscal year 1992, and $72,900,000 for fiscal year 1993; and

(5) Advisory and Oversight Program Direction and Policy Management for Energy Research activities,

$10,100,000 for fiscal year 1992, and $10,500,000 for fiscal year 1993.

Notwithstanding paragraphs (1) through (5), the total amount authorized to be appropriated under this subsection shall not exceed $806,700,000.

(b) NUCLEAR ENERGY.--There are authorized to be appropriated to the Secretary, for Nuclear Energy, the following amounts:

(1) Nuclear Energy Research and Development Program, $332,100,000 for fiscal year 1992, and $351,000,000 for fiscal year 1993, including--

(A) Certification of Light Water Reactor Designs, $44,500,000, for fiscal year 1992, of which $2,000,000 shall be for first-of-a-kind engineering for initiating the first standardized commercial nuclear power plant. and $62,500,000 for fiscal year 1993, of which $20,000,000 shall be for first-of-a-kind engineering for initiating the first standardized commercial nuclear power plant;

(B) Advanced Reactor Research and Development, $60,500,000 for fiscal year 1992, and $72,000,000 for fiscal year 1993;

(C) Space Reactor Power Systems, $46,000,000 for fiscal year 1992, and $46,500,000 for fiscal year 1993;

(D) Advanced Radioisotope Power, $56,000,000 for fiscal year 1992, and $58,000,000 for fiscal year 1993;

(E) Space Exploration Initiative, $15,000,000 for fiscal year 1992, and $15,000,000 for fiscal year 1993;

(F) Facilities Support, including operations, capital equipment, and general plant construction, $99,800,000 for fiscal year 1992, and $99,800,000 for fiscal year 1993; and

(G) Program Direction, Nuclear Energy, $10,200,000 for fiscal year 1992, and $16,200,000 for fiscal year 1993; and

(2) For developing and conducting an integrated research and development program to explore new technologies for reducing, treating, transmuting, separating, recycling, storing, or otherwise mitigating hazards associated with high level radioactive waste and spent fuel from nuclear reactors, $8,000,000 for fiscal year 1992, and $8,320,000 for fiscal year 1993.

(c) FUSION ENERGY RESEARCH AND DEVELOPMENT.--There are authorized to be appropriated to the Secretary, for Fusion Energy Research and Development, the following amounts:

(1) Magnetic Fusion Energy Research, including operating activities, program direction, capital

equipment, and construction activity--

(A) $328,900,000 for fiscal year 1992, of which--

(i) $30,000,000 shall be for preconstruction activities of the Burning Plasma Experiment facility; and

(ii) $41,800,000 shall be for the Engineering Design Activity of the International Thermonuclear Engineering Reactor; and

(B) $387,000,000 for fiscal year 1993, of which $35,400,000 shall be for construction of the Burning Plasma Experiment facility; and

(2) Inertial Confinement Fusion Program, $8,200,000 for fiscal year 1992, and $14,000,000 for fiscal year 1993.

(d) ATOMIC VAPOR LASER ISOTOPE SEPARATION PROGRAM.--There are authorized to be appropriated to the Secretary, for the Atomic Vapor Laser Isotope Separation Program, the following amounts:

(1) $218,600,000 for fiscal year 1992, of which--

(A) $20,000,000 shall be for procurement of a commercial deployment contractor and a predeployment assessment of the demonstration of Atomic Vapor Laser Isotope Separation technology and the preparation of a report to the Congress, to be submitted within 90 days after completion of such demonstration, on the economic market, financing, and risk assessment for commercial deployment of such technology;

(B) $6,100,000 shall be for capital equipment; and

(C) $3,200,000 shall be for construction; and

(2) $225,800,000 for fiscal year 1993.

(e) ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT PROGRAM.--There are authorized to be appropriated to the Secretary, for corrective activities, environmental restoration, waste management, and related technology development for civilian programs and activities of the Department of Energy, $523,500,000 for fiscal year 1992, of which $79,000,000 shall be for the Fast Flux Test Facility, and $594,200,000 for fiscal year 1993, of which $69,000,000 shall be for the Fast Flux Test Facility.

(f) FOSSIL ENERGY.--There are authorized to be appropriated to the Secretary, for Fossil Energy, the following amounts:

(1) $471,000,000 for fiscal year 1992, of which--

(A) $206,000,000 shall be for Basic and Supporting Research, including Control Technology and Coal Preparation, Advanced Research and Technology Development, Coal Liquefaction, Combustion Systems, Heat Engines, Underground Coal Gasification, and Surface Coal Gasification;

(B) $89,000,000 shall be for Advanced Technology Development, including $48,000,000 for Fuel Cells, and $41,000,000 for Magnetohydrodynamics;

(C) $70,000,000 shall be for Petroleum;

(D) $23,000,000 shall be for Natural Gas;

(E) $6,000,000 shall be for Cooperative Research and Development; and

(F) $77,000,000 shall be for Supporting Activities, including Program Direction and Management Support, Environmental Restoration, and Plant and Capital Equipment; and

(2) $507,000,000 for fiscal year 1993, of which--

(A) $214,000,000 shall be for Basic and Supporting Research, including Control Technology and Coal Preparation, Advanced Research and Technology Development, Coal Liquefaction, Combustion Systems, Heat Engines, Underground Coal Gasification, and Surface Coal Gasification;

(B) $88,000,000 shall be for Advanced Technology Development, including $60,000,000 for Fuel Cells, and $28,000,000 for Magnetohydrodynamics;

(C) $90,000,000 shall be for Petroleum;

(D) $26,000,000 shall be for Natural Gas;

(E) $7,000,000 shall be for Cooperative Research and Development; and

(F) $82,000,000 shall be for Supporting Activities, including Program Direction and Management Support, Environmental Restoration, and Plant and Capital Equipment.

(g) SOLAR AND RENEWABLE ENERGY.--There are authorized to be appropriated to the Secretary, for solar and renewable energy programs, $278,900,000 for fiscal year 1992, and $335,176,000 for fiscal year 1993. Of the amounts authorized for fiscal year 1992--

(1) $213,397,000 shall be for Solar Energy, including--

(A) $3,026,000 for Solar Building Technology Research;

(B) $76,800,000 for Photovoltaic Systems, of which--

(i) $8,336,000 shall be for Fundamental Research;

(ii) $27,064,000 shall be for Advanced Materials and Devices;

(iii) $39,900,000 shall be for Collector Research and Systems Development; and

(iv) $1,500,000 shall be for Capital Equipment;

(C) $45,468,000 for Solar Thermal Energy Systems, of which--

(i) $14,900,000 shall be for Collection and Conversion;

(ii) $19,449,000 shall be for Systems Development;

(iii) $100,000 shall be for Capital Equipment; and

(iv) $11,019,000 shall be for Industry Sector Solar Industrial Applications;

(D) $47,000,000 for Biofuels Energy Systems, of which--

(i) $5,000,000 shall be for Utility Sector Biomass Systems;

(ii) $1,400,000 shall be for Industry Sector Municipal Solid Wastes;

(iii) $6,000,000 shall be for Transportation Sector Feedstock Development;

(iv) $24,200,000 shall be for Transportation Sector Biochemical Conversion;

(v) $4,200,000 shall be for Transportation Sector Thermochemical Conversion;

(vi) $4,200,000 shall be for Transportation Sector Capital Equipment; and

(vii) $2,000,000 shall be for the Regional Biomass Program;

(E) $23,000,000 for Wind Energy Systems, of which--

(i) $7,300,000 shall be for Aerodynamics and Structural Dynamics Research;

(ii) $15,500,000 shall be for Advanced Systems and Supporting Research; and

(iii) $200,000 shall be for Capital Equipment;

(F) $936,000 for Solar Program Support;

(G) $11,505,000 for the Solar Energy Research Institute; and

(H) $5,662,000 for Program Direction;

(2) $24,000,000 shall be for Geothermal Energy;

(3) $32,257,000 shall be for Electric Energy Systems, including $6,500,000 for Electric Field Effects, of which $1,500,000 shall be for the establishment of a grant to the private sector for the assessment of the effects of exposure to electromagnetic fields; and

(4) $9,246,000 shall be for Energy Storage Systems, including $4,600,000 for Hydrogen Research.

(h) ENERGY CONSERVATION.--There are authorized to be appropriated to the Secretary, for energy conservation programs, $326,900,000 for fiscal year 1992, and $392,150,000 for fiscal year 1993. Of the amounts authorized for fiscal year 1992--

(1) $68,000,000 shall be for Building Sector,

including--

(A) $5,872,000 for Solar Technologies;

(B) $9,140,000 for Materials and Structures;

(C) $7,450,000 for Lighting and Appliances, of which $1,000,000 shall be for a lighting diode initiative;

(D) $18,680,000 for Heating and Cooling Equipment, of which $2,500,000 shall be for testing new residential heat pumps in cooperation with the Gas Research Institute;

(E) $3,149,000 for Indoor Air Quality;

(F) $16,344,000 for Building Systems Research, of which $2,500,000 shall be for a new initiative on industrialized housing; and

(G) $7,365,000 for Management;

(2) $118,000,000 shall be for Industry Sector, including--

(A) $19,590,000 for Industrial Wastes, of which $1,000,000 shall be for a new initiative to conduct research and development for waste minimization at small- and medium-sized firms;

(B) $6,300,000 for Municipal Solid Wastes;

(C) $7,264,000 for Cogeneration;

(D) $2,500,000 for Electric Drives;

(E) $20,871,000 for Materials Processing, of which $17,968,000 shall be for the Metals Initiative as provided in subsection (l) of this section;

(F) $6,947,000 for Separations;

(G) $2,410,000 for Sensors and Controls;

(H) $6,000,000 for Bioprocessing;

(I) $19,911,000 for Enabling Materials;

(J) $10,872,000 for Improved Combustion Efficiency, including diesel engine research and a cooperative initiative with the Gas Research Institute;

(K) $6,860,000 for Process Heating and Cooling; and

(L) $8,475,000 for Management;

(3) $132,000,000 shall be for Transportation Sector, including--

(A) $21,000,000 for Alternative Fuels Utilization, of which $8,000,000 shall be for engine optimization;

(B) $28,800,000 for Materials Development, of which $20,000,000 shall be for Ceramic Technology;

(C) $22,513,000 for Heat Engine Development, of which--

(i) $15,513,000 shall be for Light Duty Engine Development; and

(ii) $7,000,000 shall be for Heavy Duty

Engine Development;

(D) $52,432,000 for Electric and Hybrid Propulsion Development, of which--

(i) $27,000,000 shall be for an industry consortium for battery research and development;

(ii) $5,000,000 shall be for basic research;

(iii) $13,332,000 shall be for fuel cells, including $2,832,000 for a zero emission hydrogen vehicle; and

(iv) $7,100,000 shall be for systems development; and

(E) $7,255,000 for Management; and

(4) $8,900,000 shall be for Utility Sector.

(i) BIOLOGICAL AND ENVIRONMENTAL RESEARCH PROGRAM.--There are authorized to be appropriated to the Secretary, for biological and environmental research, $311,560,000 for fiscal year 1992, and $330,500,000 for fiscal year 1993.

(j) ENVIRONMENT, SAFETY, AND HEALTH PROGRAM.--There are authorized to be appropriated to the Secretary, for the environment, safety, and health program, $142,309,000 for fiscal year 1992, and $156,540,000 for fiscal year 1993. Of the amounts authorized for fiscal year 1992--

(1) $10,920,000 shall be for Special Projects;

(2) $18,240,000 shall be for Environment;

(3) $24,620,000 shall be for Safety and Quality

Assurance;

(4) $62,239,000 shall be for Health;

(5) $4,100,000 shall be for Planning;

(6) $20,590,000 shall be for Program Direction; and

(7) $1,600,000 shall be for Capital Equipment.

(k) LIQUEFIED GASEOUS FUELS SPILL TEST FACILITY.--There are authorized to be appropriated to the Secretary, for the Liquefied Gaseous Fuels Spill Test Facility, $2,115,000 for fiscal year 1992, and $3,000,000 for fiscal year 1993.

(l) STEEL AND ALUMINUM RESEARCH.--The Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988 is amended--

(1) in section 4(b)(5), by striking ``Industrial Programs'' and inserting in lieu thereof ``Industrial Technologies'';

(2) in section 8, by inserting at the end the following new sentence: ``The report submitted at the close of fiscal year 1993 shall also contain a complete summary of activities under the management plan and the research plan from the first year of their operation, along with an analysis of the extent to which they have succeeded in accomplishing the purposes of this Act.'';

(3) in section 9(a)(1), by striking ``and $25,000,000 for fiscal year 1991'' and inserting in lieu thereof ``$25,000,000 for fiscal year 1991, $17,968,000 for

fiscal year 1992, and $20,700,000 for fiscal year 1993'';

(4) in section 9(b), by striking ``and 1991'' and inserting in lieu thereof ``1991, 1992, and 1993''; and

(5) in section 11(a), by striking ``or fiscal year 1991'' both places it appears and inserting in lieu thereof ``fiscal year 1991, fiscal year 1992, or fiscal year 1993''.

(m) REPEALS.--(1) The Renewable Energy and Energy Efficiency Technology Competitiveness Act of 1989 is amended--

(A) in section 4(c)(1)(C), by striking ``Program;'' and inserting in lieu thereof ``Program.'';

(B) by striking section 4(c)(2) and (3);

(C) in section 5(1)(B), by striking ``program;'' and inserting in lieu thereof ``program.''; and

(D) by striking section 5(2) and (3).

(2) Section 109 of the Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Act of 1990 is amended by striking ``other Acts)'' and all that follows through ``$10,000,000'' and inserting in lieu thereof ``other Acts) $10,000,000''.

SEC. 5. MAJOR CONSTRUCTION POLICY.

(a) STATEMENT OF POLICY.--(1) It shall be the policy of the United States, with respect to substantial construction projects of the Department of Energy in civilian energy research and development areas, to authorize appropriations for the life of such substantial construction projects when the projects are initially authorized.

(2) It shall be the policy of the United States, with respect to major construction projects of the Department of Energy in civilian energy research and development areas, to authorize appropriations for the life of such major construction projects when the preliminary design phase is completed and appropriate information is provided to the Congress with respect to anticipated costs and schedules.

(b) REPORT TO CONGRESS.--The Secretary shall, after completion of the preliminary design phase of a major construction project, submit to the Congress a report containing--

(1) an estimate of the total cost of construction of the facility;

(2) an estimate of the time required to complete construction;

(3) an estimate of the annual operating costs of the facility;

(4) the intended useful operating life of the facility; and

(5) an identification of any existing facilities to be closed as a result of the operation of the facility.

SEC. 6. ADVANCED NEUTRON SOURCE AND BURNING PLASMA EXPERIMENT

MAJOR CONSTRUCTION REPORTS.

The Secretary shall, within 120 days after the date of completion of the preliminary design phase of the Advanced Neutron Source major construction project, and of the Burning Plasma Experiment major construction project, provide the Congress with information on the anticipated cost and schedule with respect to each such project, to enable the Congress to consider authorization of each such project in its entirety as a major construction project.

SEC. 7. ATOMIC VAPOR LASER ISOTOPE SEPARATION.

(a) DEPLOYMENT CONTRACTOR.--The Secretary shall proceed expeditiously to procure a deployment contractor for the commercialization of the Atomic Vapor Laser Isotope Separation technology.

(b) IDENTIFICATION OF ALTERNATIVE APPLICATIONS.--The Secretary shall authorize the University of California and Martin Marietta Energy Systems, Inc. to enter into cooperative research and development agreements with private sector entities to identify and develop non-uranium enrichment applications of the Atomic Vapor Laser Isotope Separation technologies.

SEC. 8. STANDARDIZED COMMERCIAL NUCLEAR POWER PLANT.

(a) AWARD OF CONTRACT.--The Secretary shall award a contract for further design and engineering with respect to a standardized commercial nuclear power plant design that has been certified by the Nuclear Regulatory Commission.

(b) SELECTION CRITERIA.--The Secretary shall award the contract under subsection (a) to an entity that certifies to the satisfaction of the Secretary that--

(1) the plant will be constructed in the United States;

(2) at least 75 percent of all design, engineering, manufacture, and construction activities in connection with the plant shall be performed in the United States;

(3) the entity is a bona fide entity normally engaged in the design, engineering, manufacture, and construction of nuclear reactors;

(4) the entity has entered into a binding agreement for construction of a nuclear power plant with a utility or private entity whose primary purpose is the production of electrical power for public consumption; and

(5) the entity has the financial resources necessary, and fully intends, to pursue the design, engineering, manufacture, and construction of a full-scale nuclear power plant of at least 600 MWe in size through completion of construction and into operation.

(c) FUNDING.--The project described in this section shall receive at least 50 percent of its funding from non-Federal sources. Federal funding for such project shall not exceed $20,000,000 for each fiscal year, and the total of Federal funding over the course of such project shall not exceed $60,000,000.

SEC. 9. HISTORICALLY BLACK COLLEGES AND UNIVERSITIES.

The Secretary shall, within 6 months after the date of enactment of this Act, submit to the Congress a report outlining plans for increasing the participation of historically black colleges and universities in the Basic Energy Science programs of the Department of Energy.

SEC. 10. RESEARCH REACTOR USER COMPLEX.

(a) PURPOSE.--The purpose of this section is to establish the Fast Flux Test Facility as a multi-mission center for the purpose of conducting research and development on isotopes and energy, to be operated by the Department of Energy in partnership with international and domestic user organizations.

(b) ESTABLISMENT.--Not later than 90 days after the date of enactment of this Act, the Secretary shall establish a research, development, and production center at the Hanford Reservation in Richland, Washington, to be known as the ``Research Reactor User Complex'' (hereafter in this section referred to as the ``RRC'').

(c) AGREEMENTS; AUTHORIZED USES.--In establishing the RRC, the Secretary shall provide that the Department of Energy, and any contractors under contract with the Department of Energy to operate the RRC, may enter into agreements with non-Federal entities (including foreign governments and foreign entities) or a consortium of such entities to use the RRC for any of the following purposes:

(1) The production of industrial and medical isotopes for use or sale, or both, by the non-Federal entities who have entered into the agreement.

(2) Irradiation services to support research or commercial objectives, or both.

(3) The production of steam to be used or sold, or both, by the non-Federal entities who have entered into the agreement.

(d) CHARGES.--The Secretary may assess such charges from non-Federal entities under an agreement entered into pursuant to subsection (c) as the Secretary determines may be necessary or appropriate to implement the purpose of this section.

(e) PERIOD OF AGREEMENT.--The Secretary shall not enter into an agreement pursuant to subsection (c) for a period of time exceeding 25 years.

(f) TERMINATION PROVISIONS.--(1) Under an agreement entered into pursuant to subsection (c), the Secretary may include a termination provision that requires the Department of Energy to pay for the unamortized balance of any special facilities acquired or constructed by the non-Federal entities who have entered into the agreement if--

(A) the RRC is shut down for lack of Federal appropriations; and

(B) the acquisition or construction of the special facilities constitutes a significant portion of the investment by the non-Federal entities under the agreement.

(2) A termination provision described in paragraph (1) may authorize the use, for the purpose of paying such unamortized balance and any other costs resulting from termination, of any Federal funds available for operating expenses pursuant to subsection (j)(2).

(3) For purposes of this subsection, the term ``special facilities'' means any depreciable buildings, structures, utilities, machinery, equipment, materials, or services not made available to non-Federal entities by the Department of Energy.

(g) OTHER AGREEMENT PROVISIONS.--Under an agreement entered into pursuant to subsection (c), the Secretary may--

(1) make available to non-Federal entities facilities, equipment, utility services, fire protection, and other similar services;

(2) lease real or personal property to non-Federal entities to carry out the purpose of this section;

(3) include an appropriate indemnification pursuant to section 170 d. of the Atomic Energy Act of 1954 (42

U.S.C. 2210); and

(4) include such other terms and conditions as the Secretary determines will implement the purpose of this section.

(h) COMPETITIVE PROCEDURES.--In entering into a contract with a non-Federal entity pursuant to subsection (c), the Secretary may use procedures other than competitive procedures as described in section 303 of the Federal Property and Administrative Services Act of 1949 (41 U.S.C. 253).

(i) PROVISIONS RELATING TO DEPARTMENT OF ENERGY CONTRACTOR.--A contractor under contract with the Department of Energy to operate the RRC shall--

(1) maintain and operate the Fast Flux Text Facility under contract with and for the account of the Department of Energy pursuant to section 110 of the Atomic Energy Act of 1954 (42 U.S.C. 2140);

(2) ensure that all experiments meet applicable safety requirements and acceptable criteria; and

(3) provide necessary support services to the non-Federal entities that have entered into agreements pursuant to subsection (c).

(j) RRC FUND.--(1) There is established in the Treasury of the United States a separate fund to be known as the ``RRC Fund''. The RRC Fund shall consist of all amounts received by the Secretary from charges assessed under subsection (d).

(2) Subject to appropriations, the Secretary may make expenditures from the RRC Fund each fiscal year to offset the cost of operating the RRC in such fiscal year. Amounts in the RRC Fund not needed for operations shall be invested in United States securities, the proceeds of which shall accrue to the RRC Fund.

SEC. 11. COST SHARING GUIDELINES.

The Secretary shall conduct a study of the appropriateness of cost sharing requirements for fossil research and development projects of the Department of Energy, taking into account the type of project and costs required for completion. Within 6 months after the date of enactment of this Act, the Secretary shall submit to the Congress a report containing the results of such study, along with proposed guidelines for cost sharing with respect to such projects, including provisions regarding the use of data, rights of parties, and ownership of the research results or technologies developed.

SEC. 12. ANNUAL BUDGET SUBMISSION.

The Secretary shall annually submit to Congress, along with the President's budget request, a 3-year budget estimate for the civilian research and development programs of the Department of Energy, including funding estimates for each major account and new initiative.

SEC. 13. AUTHORIZATION RESTRICTION.

Notwithstanding any other provision of this Act--

(1) no amount appropriated pursuant to this Act may be used for any program for which funding was requested in an annual budget request of the President but for which the Congress declined to authorize funding; and

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount authorized for that program under this Act.

The **Chairman**. Any further discussion?

Mr. Walker.

Mr. **Walker**. Mr. Chairman, I simply would echo that it is an excellent amendment, and we are pleased to support it.

Mrs. **Lloyd**. Mr. Chairman, I would like to commend you for your amendment, and I certainly am very supportive of your amendment.

The **Chairman**. Any further discussion?

Mr. **Morrison**. Mr. Chairman, just to agree that you have put together a package that I think brings us together.

The **Chairman**. Thank you very much, Mr. Morrison.

If there are no further comments praising the Chairman's initiative. [Laughter.]

Are there any amendments to the substitute?

Mr. **Traficant**. Mr. Chairman, for clarification, would my amendments be in order to the substitute?

The **Chairman**. Yes.

Mr. **Traficant**. I would ask consent, then, to clarify the issue that they be offered now and that the parliamentary issues be clarified later, and I offer three amendments en bloc that were previously passed on the preceding bill and asked that they be considered at this time.

[The amendments proposed en bloc by Mr. Traficant follow:]

✓ Energy
adopted
voice vote

TRAFIC064

Amendment Offered by Mr. Traficant
to the Amendment in the Nature of a Substitute

Page 25, after line 9, insert the following new section:

SEC. 14. BUY AMERICA PROVISIONS.

(a) Restrictions on Contract Awards.--No contract or subcontract made with funds authorized under this Act or any amendment made by this Act may be awarded for the procurement of an article, material, or supply produced or manufactured in a foreign country whose government unfairly maintains in government procurement a significant and persistent pattern or practice of discrimination against United States products or services which results in identifiable harm to United States businesses, as identified by the President pursuant to subsection (g)(1)(A) of section 305 of the Trade Agreements Act of 1979 (19 U.S.C. 2515(g)(1)(A)). Any such determination shall be made in accordance with such section 305.

(b) Prohibition Against Fraudulent Use of ``Made in America'' Labels.--If it has been finally determined by a court or Federal agency that any person intentionally affixed a label bearing a ``Made in America'' inscription, or an inscription with the same meaning, to any product sold in or shipped to the United States that is not made in the United States, that person shall be ineligible to receive any contract or subcontract from the Department of Energy, pursuant to the debarment, suspension, and ineligibility procedures in subpart 9.4 of chapter 1 of title 48, Code of Federal Regulations.

(c) BUY AMERICAN REQUIREMENT.--(1) The Secretary is authorized to award to a domestic firm a contract for the purchase of goods that, under the use of competitive procedures, would be awarded to a foreign firm, if--

(A) the final product of the domestic firm will be completely assembled in the United States;

(B) when completely assembled, more than 50 percent of the final product of the domestic firm will be domestically produced; and

(C) the difference between the bids submitted by the foreign and domestic firms is not more than 6 percent.

(2) This subsection shall not apply to the extent to which--

(A) in the opinion of the Secretary, after taking into consideration international obligations and trade relations, such applicability would not be in the public interest;

(B) in the opinion of the Secretary, after consultation with the Secretary of Defense, compelling national security considerations require otherwise; or

(C) the President determines that such an award would be in violation of the General Agreement on Tariffs and Trade or an international agreement to which the United States is a party.

(3) This subsection shall apply only to contracts made for which--

(A) amounts are authorized by this Act, or any amendment made by this Act, to be made available; and

(B) solicitations for bids are issued after the date of enactment of this Act.

(4) The Secretary, before January 1, 1993, shall report to the Congress on contracts covered under this subsection--

(A) entered into with foreign firms pursuant to a determination made under paragraph (2) of this subsection; and

(B) awarded to domestic firms pursuant to paragraph (1) of this subsection, in fiscal years 1991 and 1992.

(5) For the purposes of this subsection--

(A) the term ``domestic firm'' means a business entity that is incorporated in the United States and that conducts business operations in the United States; and

(B) the term ``foreign firm'' means a business entity not described in subparagraph (A).

The **Chairman**. Are these the same amendments——

Mr. **Traficant**. Yes, they are, Mr. Chairman.

The **Chairman**. If the Chairman accepted them before, he has no choice but to accept them again.

Mr. **Traficant**. Thank God. [Laughter.]

The **Chairman**. Does anybody on the minority side wish to accept them?

Mr. **Morrison**. Mr. Chairman, we also have no choice on this. [Laughter.]

The **Chairman**. Oh. I was hoping they'd object to them, but since they don't, the Chair will put the amendment to the substitute first.

Those in favor of Mr. Traficant's amendment will signify by saying aye.

[Chorus of ayes.]

The **Chairman**. Opposed, no.

[No response.]

The **Chairman**. The ayes have it, and the amendment is accepted.

The Chair will now put the question on——

Mr. **Morrison**. Mr. Chairman, I would like to at least have an opportunity to mention the en bloc amendments, which I intend to withdraw.

The **Chairman**. The Chair is happy to recognize the gentleman from Washington.

Mr. **Morrison**. Mr. Chairman, this is in the spirit of this entire markup that I will withdraw the en bloc amendments that I had proposed to your substitute. I just would ask, though, for a couple of moments to report to the committee that some very spirited efforts have gone into attempting to close the loop even a little tighter. Mr. Walker has some interests, and you, Mr. Chairman, as you have mentioned in your opening comments. I certainly have, on behalf of advancing the concept called first-of-a-kind engineering, which is one of the top priorities for the Department of Energy.

We're so close to having the right verbiage here. And, I just wanted to get assurance from you, Mr. Chairman, that this subject area of these amendments is what you mentioned, or at least part of what you mentioned, in your opening comments that you would be offering amendments that would cover these areas.

The **Chairman**. Would the gentleman yield?

Mr. **Morrison**. I will yield to the Chairman.

The **Chairman**. I am familiar with the gentleman's amendments and the efforts that he's making to reconcile these amendments so that all points of view are properly represented. I think that the only problems that we have now are making sure that the final language has been reviewed by sufficient individuals so that we don't have any misunderstandings, and I reiterate my comment to work with the gentleman and to offer this en bloc amendment as a floor package as soon as we make sure that it's adequately reviewed.

Mr. **Morrison**. I thank the Chairman, and I yield to my ranking member.

Mr. **Walker**. That's certainly my understanding, and as the gentleman may know, Chairman Brown and I share a very avid interest in advancing hydrogen research. That is one of the things that was going to be corrected in the gentleman's en bloc amendment. It is certainly one of the things that we want to work on for the future, and I think we are going to be able to work out some of these areas. So, I thank the gentleman.

Mr. MORRISON. With the assurance of my two leaders and my discussions with my Chairman, Mrs. Lloyd, I would ask to withdraw the amendment.

The CHAIRMAN. Without objection, the gentleman's request is granted.

The Chair recognizes Mrs. Lloyd.

Mrs. LLOYD. Mr. Chairman, I, too, want to address the concerns of Mr. Morrison that I also share.

I think we all had problems as we looked at the programs under our jurisdiction, and there were a lot of changes we would have liked to have made. Unfortunately, we were restricted by budgetary constraints, and I do hope we can make it an even better, more balanced bill.

At this time, I'd like to offer an amendment that Mr. Valentine had planned to offer. I don't have any objection to it.

The CHAIRMAN. Would the staff distribute the amendment by Mr. Valentine?

Mrs. LLOYD. Mr. Chairman, this provides $6 million for technical and financial assistance for Inventions and Innovations. It will be transferred to the National Institute of Standards and Technology to carry out its functions under section 14 of the Federal Non-Nuclear Energy Research and Development Act of 1974.

I think it's a good amendment. I don't have any objection to this amendment.

[The amendment proposed by Mr. Valentine follows:]

(C) ✓ adopted - as modified: voice vote

TB090

H.R. 2399

AMENDMENT OFFERED BY Mr. Valentine

TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE

Page 11, line 22, strike ``$326,900,000'' and insert in lieu thereof ``~~$333,100,000~~''. "$332,900,000."

Page 14, line 12, strike ``and''.

Page 14, line 13, strike the period and insert in lieu thereof ``; and''.

Page 14, after line 13, insert the following new paragraph:

(5) ~~$6,200,000~~ $6,000,000 shall be for Technical and Financial assistance for the Inventions and Innovations, ~~Program,~~ of which $2,200,000 shall be transferred to the National Institute of Standards and Technology to carry out its functions under section 14 of the Federal Nonnuclear Energy Research and Development Act of 1974.

The **Chairman**. Any further discussion of this amendment by Mr. Valentine?

[No response.]

The **Chairman**. The Chair has been assured by the staff that this is a proper amendment and does not disturb the delicate balance that we've reached in the substitute amendment and is willing to accept it.

Mrs. **Lloyd**. Mr. Chairman, I move the adoption of the amendment.

The **Chairman**. The gentlelady moves the adoption of the amendment. Is there any further discussion on the part of any member?

[No response.]

The **Chairman**. If not, the Chair will put the question.

All those in favor, signify by saying aye.

[Chorus of ayes.]

The **Chairman**. Opposed, no.

[No response.]

The **Chairman**. The ayes have it, and the amendment is agreed to.

Are there further amendments to the Chairman's substitute?

[No response.]

The **Chairman**. If not, the Chair will put the question.

All those in favor, signify by saying aye.

[Chorus of ayes.]

The **Chairman**. Opposed, no.

[No response.]

The **Chairman**. The ayes have it, and the Chairman's substitute is adopted.

We should put the question, I guess, on the bill, as amended. Is that right?

At this time, we should consider any proposed committee views or report language.

Mr. Mineta?

Mr. **Mineta**. Mr. Chairman, I have an amendment as it relates to the report of the committee, and I first want to congratulate you for the markup session, as well as Mr. Walker and all the Subcommittee Chairs and Ranking Republicans for their hard work on the bills that are coming before us today.

The amendment I am offering today will require the Secretary of Commerce to report on the degree to which there is interaction between private industry and the national laboratories in selecting research goals and objectives. A major obstacle facing high-technology industries in the United States today, Mr. Chairman, is the staggering cost and high risks of commercializing new technologies. Approximately $20 billion worth of research and development is conducted by Federal laboratories annually. Half of the R&D funded in this country is conducted by the Federal Government. Federal laboratories employ a total of 185,000 scientists, and this represents one-sixth of the Nation's scientists.

The challenge for both our Government and our industry is to work together to create the conditions that will make the United States competitive in the world economy. A role that the Federal Government must play in this relationship is one that will create an environment that fosters and supports the transfer of technology from the Federal laboratory to the commercial sector.

So, Mr. Chairman, my amendment will call upon the Secretary of Energy to examine the ways the resources within the national labs are used to advance technological innovations so that we can examine how to improve the competitiveness of the private sector.

[The amendment proposed by Mr. Mineta follows:]

[illegible]

AMENDMENT TO COMMITTEE REPORT LANGUAGE
OFFERED BY MR. MINETA

✓ (a)
Adopted as modified, voice vote

Page ___.

STRATEGIC REPORT.--The Committee directs the Secretary, within 6 months after the enactment of this Act, to submit to Congress a report outlining the extent to which the national laboratories are being utilized to enhance our nation's industrial competitiveness in high technology industries. The Report should contain a detailed analysis of any research efforts, current or planned, within the National Laboratories to respond to the long-term needs of generic, pre-competitive technologies including, but not limited to, biotechnology, semiconductors, supercomputers, and high definition systems. The Report should detail the degree of cooperation between the Department and critical high technology industries in formulating research goals and the extent to which the competitiveness of these high technology industries factor into research decisions.

superconductors,

Mr. WALKER. Will the gentleman yield?

Mr. MINETA. I'd be more than pleased to yield.

Mr. WALKER. I just want to clarify one thing. The gentleman, in his early remarks, referred to the Secretary of Commerce. It is our understanding that, because of the nature of the bill, it would be the Secretary of Energy.

Mr. MINETA. It would be the Secretary of Energy. I'm sorry.

Mr. WALKER. I thank the gentleman.

Mr. RITTER. Will the gentleman yield?

The CHAIRMAN. The gentleman from Pennsylvania?

Mr. MINETA. I would be pleased to yield.

Mr. RITTER. Well, first of all, I want to commend the gentleman on his movement toward bringing these critical technologies to the forefront, bringing focus to them, and his interest in seeing to it that what we do is also coordinated with what the private sector is doing, so that the right hand does know what the left hand is doing.

I also want to submit that if we could simply put into the sentence that talks about "including but not limited to biotechnology, semiconductors, supercomputers, and high-definition systems,"—if we could enter in "superconductivity" as well. I think it stands appropriately with those other fields.

Mr. MINETA. I have no objection to the addition of superconductors.

Mr. RITTER. I thank the gentleman.

The CHAIRMAN. Without objection, that change will be made.

Is there any further discussion of Mr. Mineta's proposed addition to the report language?

[No response.]

The CHAIRMAN. If not, without objection, that will be accepted.

Are there any further proposals for changes in report language?

[No response.]

The CHAIRMAN. If not, it will be in order to have a motion to report the bill.

Mr. WALKER. Mr. Chairman, I move that the Committee report the bill H.R. 2399, as amended, and instruct the staff to prepare the legislative report and to make technical and conforming amendments, and that the Chairman take all necessary steps to bring the bill before the House for consideration.

The CHAIRMAN. You've heard the motion. Is there any debate on the motion?

[No response.]

The CHAIRMAN. If not, the Chair will put the question.

All those in favor, signify by saying aye.

[Chorus of ayes.]

The CHAIRMAN. Opposed, no.

[No response.]

The CHAIRMAN. The ayes have it, and the bill is reported.

[Following consideration of H.R. 2399, the Committee considered H.R. 2404, the Environmental Research, Development Demonstration Authorization Act of 1991. At 12:27 p.m., the Committee adjourned, to reconvene at the call of the Chair.]

44-280 (728)

○